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# EDITORIAL.

## ITEMS AND NOVELTIES.

**The Cornwall Suspension Bridge.**—On the 17th of April, a Bill was passed in the New York Assembly, authorizing such works as will facilitate the construction of the Newburgh and Wallkill Valley Railroad, under the title of "The Cornwall Suspension Bridge Act." It includes, besides the erection of the bridge, the construction of 11 miles of railway to connect the Pennsylvania coal district with the New England and Western States, and, when completed, will command the whole of the anthracite coal traffic from the Wyoming, Middle and Schuylkill mines, by which a saving of 100 miles of water carriage will be effected. At present over a million of tons are annually carried down the Hudson and Long Island Sound, to be deposited at the various railway depots along the coast, whence they are conveyed throughout the States.

The great width of the river has hitherto prevented any scheme for the erection of a railroad bridge from being set on foot, and the present design is a bolder one than the great New York bridge of Mr. Roebling.

It will be a suspended girder of 1800 ft. span, placed 150 ft. above water level, and will accommodate only a single line of way. At the point selected for its erection, the Hudson River narrows into a gorge, and flows with a depth of water of 117 ft. One tower will be in 30 ft. of water, the other will be a land pier, and as the foundations are of granite, less difficulty will be experienced with that part of the work than Mr. Roebling is likely to meet with in his New York bridge. Colonel Julius W. Adams, who has just been appointed the engineer to this great work, has estimated the cost at 2,000,000 dollars. We shall publish the drawings of the bridge as soon as they are fully worked out.

**The Port of Rotterdam.**—Works for the improvement of the fluvial navigation from Rotterdam to the sea, have been pushed forward with great activity of late; and a canal, which will establish more direct communication with the sea, is expected to be opened in the course of the current year. Not only will the canal establish more direct communication between the sea and Rotterdam, but it will also enable vessels of heavier tonnage to get up to Rotterdam.

**Furnace Granite Quarries—Explosion of Three Tons of Gunpowder.**—On Saturday last, a large blast was fired off successfully at Furnace Granite Quarries, Lochfyneside, on the principle of mining and rock-blasting, introduced by Mr. William Sim, in 1853. The mines and headings on this occasion were driven in a horizontal direction from the face of the quarry, commencing at a a point about 40 ft. above the level of the quarry floor, and 80 ft. from the top. The first heading was driven inwards 46 ft., and a cross mine taken off from it to a distance of 41 ft., at the inner end of which a chamber was formed to receive three tons of gunpowder. The powder having been carefully deposited, the chamber and mines were hermetically sealed by means of rubble stone building set in Roman cement—the wooden casement to protect the wires and fuse being carried through the building in its full line of length. The gunpowder having been ignited by means of a submarine fuse, exploded without any sharp report, concussion, or stones flying, as is usual in the case of ordinary or small blasts, and displaced a mass of rock, computed at no less than 30,000 tons.

**The Mont Cenis Railway.**—Advices from Mont Cenis state that the trial trains began to run some days since between St. Michel and Susa. One engine, with a load of 25 tons, made the journey

to Susa on the 20th of April, returning the following day. On the the 23d another engine performed the double journey from St. Michel to Susa and back (96 miles) on the same day, running the 43 miles in five and a half hours, including an hour of stoppages on the road. The working of the engines is said to be satisfactory. On the 1st inst. the Franco-Italian Commissioners completed their examination of the line, and authorized its being opened for goods traffic for a fortnight prior to the opening for passengers. On the return journey of the Commissioners from Susa to St. Michel, the time occupied was 5 h. 30 min., including 1 h. 15 min. stoppages. The average running speed was about 12 miles an hour.

**The Pacific Railroad.**—The rails of the Pacific Railroad were laid on the 18th of April, across the Rocky Mountain summit of the line. This point, as we learn, is 8,242 feet above the level of the sea, being the highest point reached by any railroad in the world. A distance of 600 miles from Omaha has now been reached.

**The New Freight Depot** of the Hudson River railroad in New York, is to be by far the most magnificent ever erected in this country. It extends 405 ft. on Beach and Laigh Sts., and 439 ft. on Varrick and Hudson. An area of 178,327½ square feet, or over four acres under a single roof. It is to have three stories and a basement, will be about 60 feet high from the ground, on the average, and will be composed wholly of stone, iron and brick, making it fire-proof.

**Italian Industry.**—Great efforts are now being made to develope national industry in Italy, and to put manufacturers there on a level with those of other countries. At Lodi, upwards of 100 power looms for cotton and woolens are being fixed, and will soon be ready for work. A like number are being added to a factory at Monza, near Milan. Three factories are being established at Novara, Ivrea, and Belluna. At a factory at Tolmezzo, in the Friuli, several power looms are being added. An extensive factory is being established at Pordenone. At Piazzola, Signor Camerini is establishing a spinning mill for flax and wool. The well-known woolen factory at Schio, of Signor Rossi, is also being enlarged, and various new machines are being fixed. In Tuscany also, a woolen factory is being enlarged. During the last two months a good deal of English and Belgian machinery has been sent to Italy. The Exhibition of National Industry, now open at Turin, is a great success, and great credit is due to the committee of the *Lega Pacifica* (a league

for the encouragement of national industry) who organized it on so short a notice. This exhibition will remain open until the end of June.

**Artesian Wells, Chicago.**—There are two artesian wells in Chicago, one 700 ft. and the other about 1000 ft. in depth, with a diameter of six inches. They were bored by a company of oil speculators, upon the representations of a spiritual medium, that petroleum existed in large quantities beneath. But, before they "struck ile," they had come upon water, which has ever since continued to flow almost to the full capacity of the bore. It is said that 800,000 gallons are discharged daily.

**Powerful Centrifugal Pumps.**—We notice in *Engineering* of a recent date, a description of two very powerful centrifugal pumps, to be constructed by the Messrs. Gwinne, of the Hammersmith Iron Works, England. They are intended for draining purposes in Denmark, and are to lift each 50,000 gallons of water per minute to a height of six feet. The revolving fans will be four feet six inches in diameter, and the suction and delivery pipes three feet six inches in diameter. They are to be worked by engines of 200 horse-power, and may be driven to lift 90,000 gallons per minute.

**The New Graving Dock at Malta** was inaugurated (as we mentioned in our October number for 1867), on the first of August, by the laying of the corner-stone forty-one feet below the sea level. This dock is the largest constructed. Its length on floor will be 430 feet, and coping 468 feet. Width of floor, forty-two feet; width at broad altar, eighty-four feet; depth, thirty-nine feet. The caisson for closing this new dock is under construction; the entrance is eighty feet wide. The work weighs 300 tons, and was designed by Colonel Clarke, Director of works of the Admiralty, England.

**Steam on Canals.**—A canal company has been formed to build a steam-tug, and apply it to a new plan for towing on the Erie Canal.

It is claimed that this method will reduce the cost of transportation and time occupied between Buffalo and New York one-half.

**The Water-Power of Maine.**—The reports of the hydrographic survey now going on in Maine, show that the State has 1955 sites of water-power, with a working energy of 300,000 horse-power equal to a force of 4,000,000 men. This water-power is scattered through every section of the State. Owing to the body of water in the 1568 lakes which form large reservoirs, and cover 2441 square miles,

the force of the streams flowing from them is more uniform throughout the year than elsewhere.

**Hutchesontown Bridge.**—The old Hutchesontown bridge is now in course of demolition. The parapets, and part of the roadway have been removed to make way for the temporary side staging, and the arches are being centred with malleable iron frames, on rather a novel plan. These centres are two in number for each arch, and are composed of old rails, formed into a truss, placed 8 ft. apart, and secured at the crown with suitable bearing-beams, and at the centre and bottom, carefully united, so as to form a solid frame, resting on transverse sleepers placed on the footings of the old bridge. This frame being set in position, a portion of the arching will be cut off the entire face to a depth of 6 or 7 ft.; then the frame will be moved inwards to the next section, and so on. Thus the old bridge will be gradually removed only, as the permanent cylinders are set; but as it is intended to take advantage of the old structure for a service roadway, and to give partial support to the temporary staging, and works which are required for the erection of the new bridge-piers and arches, as far as this can be done, it may be some considerable time before the old bridge is entirely removed. The greater part of the cast iron cylinders are already cast, and a portion delivered on the ground, for the abutment foundations. The contractors have commenced to set up the guide, staging for the east side cylinders of the southern abutment, and have some already fixed ready for sinking. These cylinders having been sunk to the hard substratum, by dredging out the material inside, so that they may descend of their own weight to the required depth: they will be entirely filled up with hydraulic concrete. The heads of the cylinders will then be partially inclosed by a strong cast iron casing frame, and the interior filled up with the same material to the level of low water. The piers and abutment foundations will next be placed immediately on the top of this bed, and formed of freestone, and faced up with gray granite on the exteriors of piers and abutments. The superstructure of the bridge is composed of two piers and three arches of great span. The latter are constructed of malleable iron frames, and surmounted by an ornamental cast iron moulding and parapet—the centre arch bearing the arms of the city in relief. The engineers are Messrs. Bell and Miller, C.E., of this city. Messrs. Hanna, Donald, and Wilson, Abbey Works, Paisley, are the contractors, and Mr. John Kyle, resident engineer.—*Engineering.*

**New Invention for Watering and Cleansing Streets.**—Workmen are at present engaged in Buchanan Street, one of the principal Glasgow thoroughfares, laying down pipes which are to be connected with the water mains, for the purpose of watering and cleansing the causeway. The work is being done with the sanction of the police board, by Mr. Sim, who has patented the invention that is now to be put on trial practically. The pipes are of malleable iron, about 3 in. in diameter, and are laid down immediately outside the pavement on one side of the street only. The water is to escape by openings of $\frac{1}{16}$ in. diameter, drilled about a foot apart. By means of this arrangement, Mr. Sim expects to be able to lay dust at a much cheaper rate than by the old water-butt process, and he will use it in cleansing likewise in conjunction with the scavenger's broom.

**Foreign Competition with British Manufacturers.**—The *London Review* says: "An English manufacturer met a friend, the other day, in London. 'What are you doing here?' he said. The other told him, in confidence, that he was waiting to know the result of a competition for a large quantity of work. 'I fully expect the work,' he said, 'for I have tendered at a price by which we shall loose, merely to keep the works open.' The other asked if he had any objection to exchange figures with him, as the tenders were all in, and he had himself tendered for a Belgian firm. The Englishman named his price. 'You may go home, then,' said the other; 'I am 15s. a ton below you, and it will pay our firm very well at that price.'"

**The Suez Canal.**—We received yesterday some important details as to the progress of the Suez canal works. It appears, that in the month ending, March 15, the total extraction of earth amounted to 1,554,630 cubic mètres, as compared with 1,466,428 cubic mètres, in the month ending, February 15, and 1,130,386 cubic mètres, in the month ending, January 15. The quantity of earth remaining to be extracted, March 15, 1868, was estimated at 36,005,131 cubic mètres. It will be seen that the extraction is progressively increasing, and it is now calculated that the canal will be completed by the close of 1869.—*Engineering.*

**Centrifugal Pumps.**—Messrs. John and Henry Gwynne, of the Hammersmith Ironworks, have concluded a contract for the construction of two of the very largest centrifugal pumps ever made. They are for draining purposes in Denmark, and are in-

tended to lift each 50,000 gallons of water per minute to a height of 6 ft. The revolving fans will be 4 ft. 6 in. in diameter, and the suction and delivery pipes 3 ft. 6 in. Centrifugal pumps are classed in the trade by the size of the pipes, and these are therefore classed as 3 ft. 6 in. pumps. The engines for driving them will be made by Messrs. Kitson and Co., of the Airedale Foundry, Leeds. They will be a pair of combined, horizontal, high-pressure condensing engines, with 24 in. cylinders, and 24 in. stroke, a pump being placed at each end of the shaft. The engines will work up to 200 indicated horse-power, and may be driven to lift even 90,000 gallons per minute. The works for which this powerful machinery is to be constructed are known as the Hauveille Reclamation Works.

**Photographing the Interior of a Tunnel.**—Amongst a valuable collection of scientific books, Government reports on military and engineering matters, and photographs, just presented by Mr. Walter W. Evans, president of the Spuytem Duyvil Ironworks, New York, to the Institution of Civil Engineers, is a stereograph of the interior of the high level tunnel of the Central Pacific Railroad, 7042 ft. above the sea. Every detail is clearly visible, even to the timbering of the drifted headings. The entrance to the tunnel happens to face eastwards, and the interior is sometimes illuminated at sunrise. Advantage was taken of this; and by means of a large mirror, the light was reflected equally and gradually over the whole of the interior, whilst the picture—which was exposed fifteen minutes in the camera—was being photographed.

**West Side and Yonker's Elevated Railway.**—A private trial on the experimental line on Greenwich Street, resulted in an unqualified success, and fully satisfied its proprietors. Soon it will become one of the fixed facts of the Metropolis. A speed of seven and a half miles an hour was attained, the car starting from rest, while the rope was running at that speed. No more shock was felt than in the starting of any ordinary train.

**Brooklyn Bridge** project is resting for want of funds.—The City Council deemed that they had sufficient reasons to refuse granting the 3,000,000 dollars asked for by the Bridge Company, until Mr. Roebling's plans had been approved as to construction and cost, by a competent commission. It is more than probable, that this commission will consist of Col. J. W. Adams, Mr. W. J. Mac Alpine, and Mr. Latrobe, of Baltimore.

**A New Telegraphic Cable** has been proposed to be laid between the United States and Jamaica.

**A Curious Phenomena** has recently been shown and described in the *Mechanic's Magazine*, by Mr. Gerard.—If a ring of wire, whose diameter varies regularly so that one end is very thin, is suspended over an electro magnet, it will begin to revolve. Mr. Gerard proposes to construct a new form of telegraph upon this principle.

**Petroleum.**—M. Henry Deville, in a recent communication to the Academy of Sciences, upon American Petroleum, states that petroleum increases in bulk by one hundredth of its volume for every 10 degrees cen. of heat. A due allowance for this expansion should be made in storing petroleum in vessels for fuel, otherwise the expansion is sufficient to burst the casks, thus giving rise to terrible explosions.

**Electrical Organs.**—There has just been patented in Paris, a system for applying electricity to supersede the ordinary mechanical key and draw-stop action in large organs. The patentee has already built a Grand Electrical Organ of forty-two sounding stops and eight couplers, for St. Augustin's, Paris, and another for Salon, near Marseilles. As the largest organs may be played through wires, the organist may be seated at any distance desired, and the organ can thus be placed in hitherto impracticable positions.

**Electro-bronzing.**—At the last meeting of the Institute was presented the following communication, accompanied by numerous and admirable specimens of the manufacture described:

To the Members of the Franklin Institute:—

GENTLEMEN,—By request of several members of your Institute, I submit specimens of my galvanic iron bronze.

The bronze, brass, German silver or any desired composite or simple metal, can (as is fully demonstrated by the specimen submitted, and by manufacturers in Berlin and Paris) be closely and perfectly deposited upon iron. The difficulties to be overcome are the proper preparation of the iron, so that every atom of surface presents a galvanic pole. To do this, every grain of sand and other impurity, has to be removed, which is accomplished by simple immersion in a chemical solution. Specimen No. 2, an iron star, will show you the effect; the holes in this piece of rough iron castings were moulding sand, and you will, upon close examination, see that no matter how deeply the sand penetrated the iron, it is perfectly removed without the slightest injury to the metal edges.

After the iron is thus perfectly cleaned, and all acids which may remain, properly neutralized, a galvanic coat of tin is quickly applied, and the possibility of rusting at once prevented. After being thus prepared, the copper, bronze, brass, or any other desired metal, is plated on by the galvanic battery. The solutions of composite metals, the proper use of the batteries and regulation of force, are of course a matter of skill and experience. I find, however, no difficulty and no failure. My batteries and solutions have been in practical operation all winter, and though we have covered a large surface of iron and zinc, show no diminution of force.

I submit to you another specimen, a rosette, which is our experimental subject; the outside is galvanized after being cleaned and tinned in the way described, the inside is simply galvanized with copper. This piece of iron has, as you can see, been exposed to the weather all winter; it has also undergone severe rubbings, scrapings and fumigations of muriatic and other acids, and yet the front, which was properly handled, presents a sturdy bronze front, while the back, coppered in the way more generally known, has long since submitted to its trials.

The expense of this process is small, after the solutions, batteries, &c., are practically fitted and in working order, but little skilled labor is required, and the galvanic combinations proceed day and night, without human assistance. My experience so far would make the cost of bronzing iron about equal to four coats of paint.

I also submit to your inspection, specimens of iron galvanized by contact. You will find these specimens covered with copper of extraordinary brilliancy and comparative thickness. The cost of this process is as near nothing as can well be; it is intended for common hardware, keys, locks, &c., and without claim to durability, lasts sufficiently to be useful both in the sale of goods and keeping them from rusting in handling. The iron articles to be galvanized in this manner, are simply tumbled in a box filled with sand, afterwards with leather, until they attain a bright surface, when they are suddenly dipped in a cold, negatively electrical copper solution, and the iron being positively electrical, an instant galvanic combination occurs, and the iron is covered with copper, as you see in specimens. Proper handling and quick drying are very important in this process, and I believe that the specimens submitted exceed in beauty and durability, anything before shown; they were dipped in a solution only recently discovered in my establishment by my

confidential assistant, H. Flisher, to whose assistance I am very highly indebted in all experiments, for the improvement of iron products, which I am constantly carrying on.

If any experiments such as, for example, the instantaneous coppering of iron, should be of interest to your members, I shall with pleasure exhibit them to all callers.

Yours, &c., HENRI H. LOVIE,

Bronze and Iron Bronze Works, 723 Jayne Street, Philadelphia.

**Correction of Compasses on Iron Vessels.**—In the *Mechanic's Magazine*, a plan is proposed to secure a neutral magnetic chamber for the Compasses of Iron Vessels. The idea is suggested by a discovery of Faraday, who found that, if a small cubical space be enclosed, by arranging square bar magnets, with the like poles in apposition, so as to form a chamber, all local magnetism inferior in power to that of the magnets, will be neutralized. This same effect would be produced with Electro Magnetic, and it is thus proposed in the journal above mentioned, to enclose ship's compasses, as a remedy for the deviation by local attraction, the Electro Magnets to be supplied by a constant battery formed by the action of sea-water upon zinc-plates.

**Magnetic Phantoms.**—The curious and beautiful radial curves that Iron filings assume, when scattered upon a sheet of paper placed over a magnet, has been suggested in the *Mechanic's Magazine*, as a means of detecting flaws in Iron; ship's chain-cables, telegraph wires, and the like. Wherever a flaw occurs, these filings will form curves around it, and thus detect at once, the presence and the exact locality of these flaws. It is thought that in this way the too common accident of the parting of ship's cables, &c., may be readily prevented

**Elastic Chain Cables.**—At a recent meeting of the Institution of Civil Engineers, a plan was proposed to render the parting of ship's cables less frequent in storms. It is to be accomplished by having a very heavy, and powerful spring attached to the cable, so that a sudden strain may be taken up in the spring. The design appears to have been favorably received by that Institution.

**Testing Telegraph Cables.**—Under this head, an interesting paper may be found in *Engineering*, of April 24th, page 401, from which we make the following abstract:—It has long been a desideratum, in the laying of Submarine Cables, to maintain an uninterrupted series of tests for the whole time of paying-out.

Some time ago Messrs. Siemens devised a very ingenious system, whereby the tests for continuity and insulation, were alternately applied by an automatic arrangement.

The plan recently introduced by Mr. Willoughby Smith effected the simultaneous application of both tests; but no provision is made for keeping up on board the ship a "test of continuity." The "test of insulation" is kept up at one end of the cable, and the "test of continuity" at the other.

A system has lately been proposed, which has the advantage of being of unlimited application, and affording an incessant communication between the shore and the ship. The shore end of the cable being landed, the conductor, or a prolongation of it, is attached to an insulating pin, and at a suitable distance from it is fixed another insulated pin, which is connected through a delicate galvanometer to earth, between these two pins an insulated pendulum is made to vibrate.

The pendulum, on touching the pin connected with the cable, takes from it a certain portion of its charge, and during its oscillation, empties into the pin which is connected with the galvanometer.

The capacity of the pin is first fixed upon for the length and electro-static relation of the cable.

Increased capacity may be given to the pendulum, by attaching to it a condenser of suitable electrical dimensions.

It will be sufficient to insulate from the other portions of the pendulum, that part which is concerned in making the contacts.

On contact with the end of the cable by the pendulum, a momentary increase in the deflection will be observed on the galvanometer of the ship, arising from the sudden increase of capacity; and this will continue as a constant range of variation in the angular deflection due to leakage on the cable itself. By means of these slight motions, a "test of continuity," without interfering with the "test of insulation," which is always kept on the ship, the observer on shore is able to know, with positive certainty, the electrical condition of the cable, by allowing the abstracted charges to flow to earth through the galvanometer, occasionally noting the deflection. If the conductor parted, and at the same time each end remained insulated, the observer would continue to get indications on his galvanometer; but the intermittent rise and fall in the galvanometer deflection in the ship would immediately cease, and the engineer would know the exact moment when continuity ceased.

The observer on shore would very soon observe, by the deflection on his galvanometer becoming gradually, but very regularly, lessened, that the conductor had parted, and the end on shore was inclosed in the insulator. If, on the other hand, the deflections suddenly ceased, he would further know that the conductor had parted, and was exposed.

If it was required to transmit messages from the ship to the shore, it would still be possible to maintain the tests, by simply varying the battery-power, so as to alter the deflection on the galvanometer at the shore-end. Of course, this would admit of too limited a number of combinations to be of service beyond the very few signs required to be transmitted, and which should not be exceeded, if possible, during the paying out of any cable.

**The action of Ozone on Sensitive Photographic Plates.**—Dr. E. Reynolds recently read a paper, giving some very curious results on the above subject, before the Dublin Chemical and Philosophical Club. In experimenting upon this subject. Dr. Reynolds found that the undeveloped image upon a sensitized plate after exposure in the camera, subjected to the action of ozone, was completely obliterated, so that a new image might be taken upon it. This fact, Dr. Reynolds remarked, proved that the production of an image was due to a chemical action, and thus overthrows the mechanical theory of photographic images. The ozone in these experiments was obtained sometimes by the aid of electricity, and sometimes by the action of air upon phosphorus.

**American Cast Iron.**—We extract from *Engineering* of April 17th, the following testimony to the wonderful excellence of the better sorts of cast iron made in this country, which, while well known to some, is not generally appreciated. An English engineer, now in New York, writes us as follows: "The cast iron here astonishes me. I saw in the Brooklyn navy yard, a cast iron naval gun, which had been hit by a Southern shot about four feet from the muzzle, and the shot had left its mark, impressing the rifling quite clearly. There was not a crack upon the surface of the gun; but the dent was driven right through the thickness of the gun, and reproduced in the chase, so that a closely fitting shot could not be fired from it."

**Method of Repairing Puddling Furnaces.**—We observe in an article describing the Martin process for production of steel, which has just appeared in *Engineering*, the following plan for the above

object. The communication with the grate or combustion chamber being shut off, the entire furnace is filled with pieces of brick and dry sand. The roof can then be removed, and a new one laid upon the sand mould thus produced, and when finished, on removal of the sand, &c., the furnace is again ready for work.

**Philosophical Society of Glasgow.**—At the last ordinary meeting of this society, on Wednesday evening last, an interesting paper was read by Mr. Mactear, of St. Rollox Chemical Works, on "The Sources from which Sulphur is obtained for making Oil of Vitrol or Sulphuric Acid." It seems that hundreds of thousands of tons of sulphuric acid are made in this country annually, and that the greater part of it is obtained by burning iron and copper pyrites, minerals which have come into extensive use since the year 1840. The brimstone which is imported, is chiefly employed in the refined state for making gunpowder. The spanish ore, from the Tharsis mines (owned chiefly by Glasgow manufacturers and capitalists) is that variety of pyrites which is most used; it contains about 48 or 50 per cent. of sulphur and 4 to 5 per cent. of copper. Mr. Mactear gave many interesting particulars regarding the Spanish ore, and regarding the physical and chemical difficulties which are encountered in burning the other varieties of ore. Sweden, Norway, Italy, Belgium, Ireland, Cornwall, and other places are now laid under demand for the wants of the vitriol manufacturers of Britain, especially those of Glasgow and the Tyne.

At the meeting of the chemical section of the same society, held on Monday evening last, Dr. Wallace, F.R.S.E., read a paper on the animal charcoal used in sugar refining on the Clyde. For the last ten or twelve years Dr. Wallace has been very prominently identified with the chemistry of sugar refining, as an analytical and consulting chemist; and on this account, as also from the circumstance that the Clyde refiners occupy the front rank in the trade, the information contained in the paper excited a considerable amount of interest, and drew together a large number of the members.

## THE NATIONAL GOVERNMENT AND THE UNIVERSITIES.

HONESTY, perseverance, and genius, are things too valuable to be lost; but our National Government is losing them and the country suffers. Herein we might learn from the monarchies of

the old world. England in the nineteenth century still regulates promotion by rank, and just so far as she so does, is risking her national supremacy. We all know how essential university education is to preferment, in Prussia. France—one good at least is gained from the first Napoleon—and still more so Russia, gather in the genius of the country to the aid of despotism, and clothe their astronomers, mathematicians, chemists, philosophers and poets in golden harness, and fasten them to the imperial chariot with ribbons of honor. Even China is beyond us in this respect. A late writer in the *North American Review*, says that "Every effort is made not only to maintain thorough honesty in the customs department of the Chinese government, but to attract to it young men of high intellectual capacity, and to this end extremely liberal salaries are paid. The employees are now taken from among the best graduates of the English and American universities, the former after a severe competitive examination. After studying the language for two years at Peking, with a salary of £400, they enter active service as clerks, with salaries increasing with promotion from £600 to £1200; and when advanced to the rank of commissioners, of whom there are thirteen, they receive, according to the port, £1200 to £2,000."

In looking over a college life, it is a matter of no small pain and surprise, to see how many young men of great promise are turned adrift on graduation day, and left to wander up and down until misfortune or good luck provides them with a situation. Some men have an avocation and know it, but these are very few, and the most seek only for an employment. Of the former, there was one among my classmates, called to be a Grecian. Not to mention other indications, he was given to chanting the chorusses from Prometheus Vinctus, Antigone, and what not, on all sorts of unseemly occasions. He hastened to Oxford, and after haunting the shades of Porson and Bentley, will return to the Greek professorship which awaits him. Then there was another who was assuredly a Latinist. But nature, with the gift, had not given its possessor a knowledge of it. I recall to-day, with pleasure, the neat turns in his translations, and the classical flow of his Latin prose. But he took perforce, a village school at Psalmaquoddy Beach, and after laying by a trifle, rose to a petty clerkship in a New York jobbing house. Then there was another, who was too proud to take a scholarship, and lived on apples and an occasional loaf of bread, smuggled home

in brown paper after nightfall. Without a friend to recommend him in the town in which he settled, he earned a pittance by fitting cubs for college. But why multiply instances. Rich as well as poor, and the colleges east and west, all suffer. It is a case in which our National Government might properly afford help, and in so doing would be immensely benefitted. It is thought highly commendable for our government to stimulate private enterprise—even where that enterprise would of itself probably have been sufficient—in building a railroad to the Pacific. Would it be any the less so, for the government to enlist in its support the vastly more valuable and important talent that is wasted for want of proper employment? Public opinion is irresistibly marching forward to the belief that partisanship is no proper qualification for office, and the time is not many years off, when appointment to office will be made to depend upon severe examination, and the retention thereof will be for life and during good behavior. Then the government service may be freed from the foul reproach which now rests upon it, and young men of honesty and talent may embark in it as a career. Where the necessities of the case bid defiance to the corruption of political patronage, examinations even at present are requisite, and every year many of the ablest graduates of our medical colleges pass at once into our army hospitals and men-of-war. When the peril of the hour made honorable competition possible to all, the graduates and members of colleges were foremost to enlist, and at the close of the war were so universally found in high commands, as to demonstrate triumphantly the value of college drill. Now, what has worked so well in the foregoing instances, should be extended to all the departments of the executive. Who so well fitted to record observations in the National Observatory, to calculate the Ephemeris, and to make soundings for our Coast Survey, as the graduates of our colleges who have studied mathematics under Peirce, Chauvenet, Loomis, Newton, Kendall, and others? Would their study of international law, of the polity of Greece and Rome, of the history of many nations, would their familiarity with the ancient and derived languages, would their culture and gentlemanly bearing, render the scions of our citizens—Americans in the fifth generation—who graduate from our colleges, less worthy to represent us abroad, than many of our present consuls and attachés? The wholesale plunder and fraud now rife in our customs and internal revenue department is filling the country with crime, and our

patriots with shame, is loading enterprise with intolerable burdens, and driving scrupulously honest men from certain forms of business. The oldest country of the globe might teach the youngest a lesson in this respect, where "the unexpected increase of the customs revenue at Shanghai, from filling the service with the best men from the English and American universities, attracted the attention of the officers of other provinces, and led to the extension of the system to every open port in China." Nor should we be blind to the advantages which would accrue from imitating the Chinese in another respect; in the foundation of professorships of the Chinese, Japanese, Hindostanee, Persian and other Oriental languages, in connection with our universities. It would not even be necessary for our government to furnish money for foundations, because as soon as it was certain that the government would employ the graduates in Eastern missions, private generosity would in this country suffice. In view of the vast number of Orientals now settled on our Pacific border, and the certainty that the commerce, wealth and population of Asia will flow in a mighty tide over our country when the railroads across the Rocky Mountains are finished, I urge the establishment of these professorships as a duty not to be delayed an hour. For proper men to treat impartially with the Indians and defend them from brutal traders, for persons keenly alive to the wants of a letter-writing people to equip our postal service, for engineers to build our ships and man the gun-boats, for purposes and positions without number, where can the government find such intelligence, Americance and fitness as our universities afford. Let it then appoint a council composed of the chief men in the National Government and representative of its various departments, like Motley, Bancroft, and Charles Francis Adams, and let them be associated with our college presidents. Let such a council appoint examining boards, devise rules for the conduct of examinations, prescribe the qualifications for success, &c. Then should we have a national government which would be stronger than steel, though without an army to defend it, because it would have enlisted in its support the moral worth, the education and the genius of the entire country.

A. R. L.

# Civil and Mechanical Engineering.

## THE SUEZ CANAL.

By Chas. H. Rockwell.

(Concluded from page 325.)

It is in this way that the site of Port Said has been raised from the level of the shallow salt lake which surrounds it; a portion of the material which has been excavated to form the channel and ship-basin at the entrance of the canal, has been used to elevate the town plot about fifteen feet above its former level; giving the foundation of an active, healthy settlement, where are now more than 8000 inhabitants. The greater portion of the excavated material will be received from the shutes of the dredges into large barges, especially provided for the purpose; of these there are two kinds. The larger ones are 142 feet long, by 23 feet beam, capable of carrying 275 cubic yards of sand, in five feet of water; the space occupied by the sand is in the centre of the boat, longitudinally, and of about one-half the total length; the material is discharged through twelve trap-doors at the bottom, six on each side of the axis; the opening and shutting of these doors being controlled by chains. The bow portion of the barge is fitted up as quarters for the crew; the stern is occupied by the boiler and engine, of sufficient power to propel the vessel five miles an hour, when loaded. In order to give increased buoyancy, there are two air-chambers running parallel with the axis of the boat, through the section where the sand is deposited, the interior sides of the chambers, sloping from the gunwales towards the centre, to facilitate the discharge of the load. These barges now convey the material which is excavated to form the channel and basin at Port Said, out to sea, some four or five miles, and drop it in deep water; they will also be used in the lakes, through which the line of canal passes, where there is sufficient depth of water. The other style of barges are especially adapted for shallow water; they are smaller than the others, and can carry 125 cubic yards of waste material on a draft of less than four feet. These have their air-chamber in the centre, parallel to the axis of the boat, with the trap-doors opening on the sides; they have engines, and screw-propellers, but of less power than those first mentioned, and are not

calculated to go into rough water. But the great mass of the material to be excavated in forming the canal, will be discharged from the buckets of the dredges into long spouts, of heavy sheet iron, which reach over the bank on either side. These spouts are sustained by a tall frame-work of iron, which rests upon the deck of a rectangular, iron float, about 96 feet long, by 28 feet broad, requiring about five feet of water. The shape of the spout is a semi-ellipse, 5 feet wide from edge to edge, and 2 feet deep; the slope of the spouts is graduated according to circumstances, but no trouble is found in working sand or clay, when the inclination is 8 per cent. of the length; the greatest length now in use is 230 feet. The contents of the buckets of the dredge when dumped into the upper end of the spout, is forced through it by means of a strong current of water, which is supplied by a rotary pump, worked by a separate engine. The longest spouts are intended to be used in connection with the largest dredges; when thus employed, their upper ends will be about 36 feet above the surface of the water; an inclination of 8 per cent. will leave the lower end about 18 feet high; this elevation will easily clear the low bank which has been formed by the smaller dredges, in digging the channel in which the larger machine operates. The float which sustains the spout is fastened by chains and braces to the hull of the dredge, so that the direction of the discharge through the spout can be changed, and its distance from the bank can be regulated by the guiding-chains, which are laid out to anchors, on the four sides of the principal machine. The extreme width of the canal will be 330 feet, as before mentioned; by means of these long spouts, a dredge can work in the centre of the channel, and at one movement can dispose of the excavated material at a good distance beyond the water line, on either side. Another advantage in the use of this apparatus has been found in the very gentle slope which is taken by the sand when thus discharged. The quantity of water pumped into the spout is as great as the amount of sand, so that the material escapes in a semi-fluid state; and the water sweeps the sand along with it to a very considerable distance, before depositing it. There has been found no difficulty in thus disposing of 200 cubic yards of material to each lineal yard of canal. This system of the spouts is considered as the especial invention of Mons. Lavalley; he has also devised means of dumping the sand over the banks in places where the cutting of the canal brings the dredges too low to render the spouts available. This is done by an inclined

plane, or traveling elevator, which consists essentially of two lines of iron rails or beams, about 160 feet in length, placed at an inclination of one to four, and sustained in the middle by a frame of wrought iron, which rests on a car, running on rails, laid along the bank of the canal, and elevated about 6 feet above the surface of the water. The lower ends of the rails or beams overhang the water, and are still further supported upon a rectangular float, which also carries a steam engine. When in operation, the apparatus is placed at right angles to the axis of the canal; the inner or lower ends of the inclined plane is now about 10 feet above the water, while the upper end is some 36 feet higher, and distant 140 feet, horizontally, reaching over the bank which has been already formed. A barge containing 7 of the large boxes, before mentioned, is now floated under the inner end of the plane, and one of the boxes, filled with sand, is raised on to a truck, which runs on the inclined beams; an endless wire rope draws the loaded truck to the upper end of the beams, where the contents of the box are dumped over the bank. These are the means which will be employed for digging all those portions of the canal where the earth is not more than 6 feet above the water line; amounting to a total distance of about 76 miles. The quantities to be moved are nearly as follows, viz: seven million cubic yards, by the sand boxes and elevators; thirteen million for the barges; and thirty-five million for the spouts; being a total of fifty-five million cubic yards.

At those points where the cutting exceeds 6 feet, the preliminary work must be done by hand labor, before the dredges can be made available. As before mentioned, the deepest cut will be at El Guisr, about 66 feet above the water line; here was concentrated the great mass of *Fellahs*, for about three years; and this is almost the only spot where any real amount of work was done by them. They cut a narrow channel through this ridge, down to a level a little below the water line. When work was resumed upon the new basis of steam power and paid labor, a contract was made with Mons. Couvreux to complete this deep cut for ten and a half million francs; and he is now doing the work with locomotives, which haul a train of loaded cars out of the excavation; the cars being loaded by hand. Except this point, the contract of Messrs. Borel and Lavalley, covers the entire line of canal. The only section where *they* have been obliged to dig by hand labor below the water line, is at Chalouf, the narrow ridge at the southern end of the Bitter Lakes. Here

their borings discovered a stratum of sand-stone about 10 feet thick, nearly at the bottom of the canal; its extent was not great, as it soon pitched below the required level. The quantity of rock excavated was about 34,000 cubic yards, covered by 165,000 cubic yards of sand and clay. The material here, was drawn out of the cutting upon 5 inclined planes running directly up the bank at right angles to the axis of the canal, and about 250 yards distant from each other; the motive power being a stationary engine at the top, drawing up two cars at a time, each containing about 4 cubic yards. The line of the fresh water canal was not far from the ship canal, at this point, and some trouble was experienced from the infiltration of water. This was soon remedied by means of three large rotary pumps.

On those sections where the surface of the ground is elevated above the reach of the dredges, the preparatory work is done by Arabs; these men swarm in from the surrounding desert, and work exceedingly well, taking small tasks or jobs. The engineers having carefully measured the quantity of earth to be moved, name the price which is to be paid for it; reference being had to the nature of the soil, as well as the distance to which the material must be transported. The company furnish all necessary tools, wheelbarrows, running-boards, &c., and name such a price for the job as will give the men about three francs for a day's work; they usually earn more than this, as they work hard, and almost uniformly finish their task before the time appointed. These men are exceedingly avaricious and fond of money, but are generally quiet, peaceable, and easily controlled; there are now probably ten thousand of them employed along the line, and this number could easily be increased if desired. But few European laborers are engaged in the actual digging of the soil by hand labor; the Arabs, Egyptians and Syrians having almost a monopoly in this department. The masons, carpenters and machinists are mainly Italians, Austrians and Dalmatians. The men who are employed on the dredges are mostly Greeks, under the direction of French engine-men and chief artizans. The staff of engineers in charge of the work, the clerks, cashiers and warehouse-men, are nearly all French. The general state of health among the workmen is very good; the mortality being only one and one-third per cent. per annum. Of the total amount of excavation to be done to complete the canal according to the plans adopted, only about one-third has yet been accomplished; but still, the enterprise as a whole, is looked upon as being more than half finished. An immense amount

of labor has been done in works of a preparatory nature, and the contractors are now in a position to push ahead with rapidity. Mons. Lavalley has stated that their outlay for machinery had already exceeded ten million dollars; besides a million and a half of dollars for preliminary expenses, such as machine shops, dwelling-houses, wharves, &c. They will have at work within a few months, 60 of the large dredges, and 16 of the smaller sizes. Of the former, 20 are to be fitted with the long spouts, and are each calculated to raise 440,000 cubic yards of material per annum. The other 40 large machines will be attended by 110 of the steam sand-barges, to transport their product. These dredges will lose some time in shifting their spouts from one barge to another, and are counted upon for a less net result, than those with the spouts, viz: 375,000 cubic yards each per annum. These results, with the assistance of the smaller machines, will make a total of twenty-five million cubic yards per annum; so that there is every prospect of the completion of the canal in the autumn of 1869. The aggregate force of the steam-engines which will be employed when all the machines are at work, will exceed ten thousand horse-power. By means of the narrow channel through the ridge of El Guisr, there is salt water communication from Port Said to Lake Timsah, and from thence by the fresh water canal to Suez. Through this shallow, crooked passage, Mons. Lavalley has sent his dredges; four of them are now at work in the Red Sea, five others are at a point some ten miles from Suez, floating in a section of the ship-canal, now filled with fresh water; while six more are doing good service at Serapeum: an artificial lake having been most skillfully formed there, and filled from the fresh water canal, at a height of 12 feet above the sea level.

The objections which have been urged against the impracticability of the Suez canal, are now found to be almost wholly without foundation. The drifting of the sand in the desert has been carefully observed and calculated; and so little does it amount to, that Mons. Lavalley declares, that with a *single one* of his dredges, he can keep the channel clear, and maintain the full depth of water throughout the whole length of the canal. The opponents of the enterprise have always laid great stress on the mud from the Nile, which would be carried eastward by the currents in such quantity, as to fill up any harbor which might be dredged at the Mediterranean entrance. The experience at Port Said during the past six years, has removed all anxiety on this score; there being no deposit at all. This is *now*

one of the best harbors on the Egyptian or Syrian coast, as vessels drawing 15 feet of water, can run in, in any weather; there were 861 entries at the port in the year 1866. During the summer of 1867, the channel will be deepened so as to admit vessels of 21 feet draft; during 1868, the depth will be increased to 25 feet, and a still greater depth will be afforded, sufficient to admit the largest class of merchant vessels, in 1869. There seems to be scarcely a doubt but that the canal will soon be completed, so as to afford a safe and easy passage between the two seas, when it will present a most striking evidence of diplomatic tact and perseverance on the part of Mons. de Lesseps, and of engineering skill by Mons. Lavalley.

It is hardly possible to say what effect this canal will have on the commerce of the world. It is almost certain to change the direction of the greater part of the shipments made between Europe and the East Indies, and must have, too, a marked influence on the United States trade with India and China.

The company are allowed to charge ten francs per ton, on all vessels passing through the canal; and if the amount of tonnage which now doubles the Cape of Good Hope should be diverted into this channel, this long-talked of enterprise will prove a great financial success.

## TELESCOPIC MEASUREMENT IN SURVEYING.

By Benjamin Smith Lyman, Mining Engineer.

Read before the Franklin Institute, at the Stated Meeting, March 18th, 1868.

(Concluded from page 319.)

Instead of reading the distance directly on the rod by the telescope, a movable target may be used with a vernier. One cross-hair is sighted at the zero point on the rod, or at a fixed target, and the movable target is moved to correspond with another cross-hair, and the space cut off in this way on the rod is read by the rodman; and if a vernier be used, can easily be read to a thousandth of a foot, if desired. Such a rod was used in the fall of 1862, in a topographical survey in Schuylkill County, with a measuring telescope that magnified about ten times attached to a light compass. There were three horizontal cross-hairs, not adjustable, but fixed, by chance, at

such a distance apart that two inches on the rod between the middle cross-hair, and either one of the others corresponded to ten feet of distance on the ground.

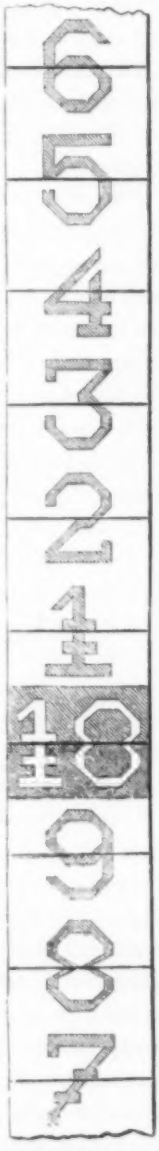
The exactness of this measurement was satisfactory, but the moving of the movable target was so tedious, that the next spring a rod was made for similar topographical use, so marked that the distances might be read directly with the same telescope. The numbers of every other division on the rod were indicated by diamond-shaped spots, two-fifths of the division in diameter, and placed on either side of a dividing line, with one point at one-fifth of the division from that line, and the opposite point at twice that distance from the next line; so that the whole of each division was easily divided by the eye into ten parts, by halving the side of a spot or halving, or quartering the space between the spot and a dividing line. The cross-hairs were put nearer together, too, so as to bring them further from the outer edge of the field. It was wished to have them just half as far apart as before; but they proved to be so far apart, that $\frac{36}{35}$ of an inch on the rod corresponded to ten feet of distance, and the rod was divided accordingly. This telescope and rod were used very successfully through the summer and fall of 1863. The first part of the season, the levels were taken by means of angles on a vertical circle, as they had been the year before; but after that, to avoid the uncertainties and excessive office work of that method, an ordinary level-rod was carried, besides the one for measuring, and the level was taken in a separate observation for each station with the help of a spirit-level attached to the telescope of the compass. The running, in such a case, is done with front and back sights, like leveling, with one rod; and, as the sights are level, no correction is needed for slope. The exactness of these methods, even with so slight an instrument as the compass was, and their thorough satisfactoriness in that respect for geological purposes are illustrated by the fact that a shaft was sunk, in 1866, in Cape Breton, at a point where it was calculated by a map constructed, in 1863, from materials obtained in this way, that the bottom of a certain coal-bed, dipping about one in ten, would be 180 feet deep, a point about three-quarters of a mile distant from the nearest exposure of the bed, when the map was made; and the depth proved, in fact, to be 182 feet.

The next winter a new rod was made and divided into feet and tenths of a foot, and marked in the same way as the other had been.

Also, the measuring cross-hairs in the telescope of a new transit, with a magnifying power of about ten times, were made adjustable by screws, so as easily to be placed just so far apart that one foot of space cut off on the rod by two near cross-hairs should indicate a distance of one hundred feet; and the rod could be used at the same time for leveling, as there was a level on the transit telescope. This apparatus was used very successfully through the summer and fall of 1864, and again in the fall of 1865. In measuring important lines, every measurement was checked by a double observation, and every compass-angle roughly checked by reading also the angle of the vernier plate; so that no station was left until it was seen that no important error in reading had been made; a mode of checking that is much better than running over a line a second time. The screws that adjust the measuring cross-hairs are just behind the screws that adjust the middle horizontal cross-hair; and as the upper one was found to be exposed to being struck and turned by the limbs of trees or bushes in carrying the transit through the woods, and so making an error in the measurements before it was discovered, a cap, open on both sides, has been put over the head of this screw, to protect it completely. The telescope of a solar compass was also furnished with one fixed and one adjustable horizontal cross-hair for measuring, and was used successfully in this way with the rod just mentioned.

The same transit was also used in the fall of 1865, with great success, for measuring underground in a coal mine, and it saved much disagreeable groping in the mud to count the links of a chain; and levels were taken at the same time, with one rod. The figures on the rod, in this case, were painted with red ink upon thin paper that had been fastened to strips of common window-glass by transparent varnish, such as photographers use on their negatives. Then another coat of varnish was poured over the paper, and another strip of glass was placed upon that. The glasses, with the paper between them, were then put into a long, narrow frame of pine wood, five-eighths of an inch thick and an inch and a-half wide in the clear, which formed one side of a long box, three inches and a quarter square inside. The box has neither top nor bottom, and its sides are so hinged together that they fold over upon each other when not in use, so as to protect the glass and take up less space. The back of the box has holes through it, to supply air to the lights; and either little mine-lamps, or candles in little tin sockets, are stuck in

the wood of the back. This box was made five feet long; but for low mines one might be made much shorter, say, a lantern one or two feet long (perhaps of tin), and for leveling it could have a leg that would slide in or out, so as to raise the lantern to the required height from the ground. The inside of the wooden box may be painted white, to reflect the light well, or be lined with tin, and the outside may be painted black, so as to show less the black dirt of coal mines and the grease and smoke of the lamps.



One-half of full size.

The figures on this underground rod are the common Arabic numerals, made a hundredth of a foot thick throughout and very angular, so that each hundredth of a foot in their height is marked by an angle. Every tenth of a foot is marked with a number, instead of every other division, as on the two other rods. The feet are marked by the same figures, but they are made white on a red ground; and the red ground reaches half a tenth of a foot each way from the foot-mark, so that the feet are very conspicuous at a distance. The rod for use with the transit above ground has now been repainted with these figures, as they are much more convenient for reading. They are cut in a stencil-plate, and are, therefore, easily marked on the rod; it would be still more convenient to stamp them with a die. They are eight hundredths of a foot long, four hundredths above and four below the line, and the fifth is easily estimated by the eye at half-way between one figure and the next. Of course, a land surveyor could have the rod divided into links and portions of a link, and marked accordingly; or he could so adjust the cross-hairs, that a foot on the rod would answer to a chain on the ground.

The rod is, then, in effect, marked with divisions a hundredth of a foot apart, and a telescope that magnifies ten times should, for distances less than a furlong, be exact to $\frac{1}{2400}$, that is, at most, about three inches; and to $\frac{1}{1200}$ for distances between a furlong and a

quarter of a mile; and with a telescope twice as powerful, should be about twice as exact, since the smallest divisions could be halved by the eye. The exactness, then, with a telescope that magnifies twenty times, is at least as great as that claimed for Porro's larger instrument. Telescopes that magnify only ten times, with this rod, would measure, on the whole, much more exactly than the chain. Of chaining, Wm. A. Burt writes as follows, in his "Key to the Solar Compass," p. 35.

"Measurements with the chain and tally-pins are often very imperfectly performed by the chain men, and much more error is made than is generally supposed. It has been found by many trials, with as good men as can generally be obtained, that with two sets of chain men, instructed alike in the proper manner of keeping the chain level and straight on the line, and of setting the tally-pins plumb, as well as holding the ends of the chain to them, a difference has sometimes been made of 36 links," ($\frac{9}{200}$) "and an average difference of 15 or 16 links to a mile" ($\frac{1}{500}$), "in common timbered land. But repeated measurements over the same mile, by the same chain men, and near the same time, will generally agree within 5 links" ($\frac{1}{1000}$); "yet, after several months' employment in the field, a measurement of this line may not agree so exactly. Again, the same chain men will make a different measurement to some extent, over swamps, marshes, wind-falls and thickets, when there is snow on the ground, and when there is none, in cold and in warm weather, effecting a change in the length of the chain, and by measuring fast or slow, the amount of error to each would be difficult to estimate."

It is seen that only in rare and favorable circumstances can a mile generally be chained within $\frac{1}{1000}$ of a second chaining. This precision of $\frac{1}{1600}$ is not more easily got by chaining, therefore, than the precision of $\frac{1}{2400}$ is got in measuring a furlong, at a single sight, with a telescope magnifying ten times; so that this telescopic measurement is at least one-half more exact than the chaining. But, as the error in reading the distance with the telescope is just as likely to enlarge as to lessen the true distance, the errors of several sights would tend to balance each other; in fact, the precision would increase as the square root of the number of sights. A mile measured in eight sights of a furlong each would be almost three times as exact as one sight, say within $\frac{1}{7000}$. A mile measured in ten sights of 528 feet each would, with the same care, be exact within about $\frac{1}{7300}$; with twenty sights of 264 feet, within $\frac{1}{11000}$, or less than six

inches. The exactness with a telescope magnifying twenty times would be twice as great. The striking advantage of the instrument, then, for exactness is unquestionable; indeed, as the exactness might be still further increased by measuring a number of miles in one line, and by painting the rod in black and white (the best colors for distinct visibility, and twice as easily seen as the red marks have been reckoned), the instrument is well fitted even for quite exact geodesical measurements. The ease with which the measurements can be checked, so that large errors of reading are avoided, should also be borne in mind.

The general ease and quickness of telescopic measuring has always been recognized. The delays of chaining are saved; at the expense, however, of an addition to the telescopic work. Not only is the great trouble of training chain men avoided, but instead of two chain men with a rod, only one rodman is needed, whose duties are so simple (merely to hold the rod plumb in a good place) that he can also serve, at times, as axe-man. As the observations at the instrument are more numerous, it is the more desirable, though not absolutely necessary, in topographical work, to have an assistant to make all the readings to be noted by the head of the party.

The adjustableness, then, of the cross-hairs, and the easily legible marking of hundredths of a foot on the rod, by means of angular figures, or otherwise, make even greater exactness attainable than by Porro's improvements, without the excessive complications of his instrument, or its niceties in workmanship; and, at the same time, permits both leveling and measuring with only one rod. The rod lighted inside makes telescopic measuring and leveling easy underground, where chaining is peculiarly disagreeable. Such measuring is far more exact than chaining, as well as quicker and easier.

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## PNEUMATIC BRIDGE FOUNDATIONS.

### Part I.—Tubes.

The very general attention and inquiry, excited among engineers and railway men, by the very interesting paper upon pile support, published by Hon. W. J. McAlpine in the February and March numbers of this *Journal*, and the somewhat inaccessible manner in which the latest information concerning the pneumatic

process is scattered in various publications, make it probable that additional details of the methods employed in Europe, and of some of the recent modifications of the process on the continent, may not prove uninteresting.

The following accounts have therefore been compiled from M. Perdonnet's works on "Railways;" M. Cézanne's "Account of some Russian Bridges;" M. Vuigner's "Rhine Bridge at Kehl;" M, Colburn's Paper "Engineering," and other sources.

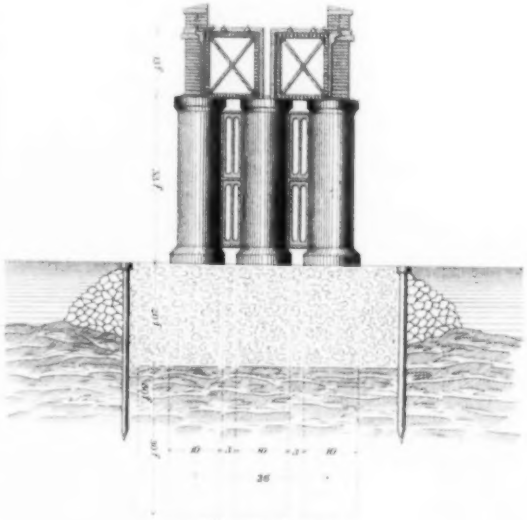
The plenum pneumatic process, first introduced by M. Triger, a French engineer, in the sinking of coal shafts from three feet four inches to six feet diameter through very wet soils, was first applied to bridge foundations by putting down a number of tubes in groups or clusters, to support, or to form a pier. Thus at the Rochester bridge, fourteen columns seven feet in diameter, support a grillage, upon which is erected a masonry pier seventy feet long, and seventeen feet eight inches wide. At the Chepstow bridge, the pier is composed of ten columns six feet four inches diameter, of which six are carried up to the bridge seat.

It was soon found, however, that but one tube could readily be sunk at a time; that in placing them close together, the putting down of one column was liable to disturb those already sunk, and that there was a manifest advantage in reducing the number and increasing the diameter.

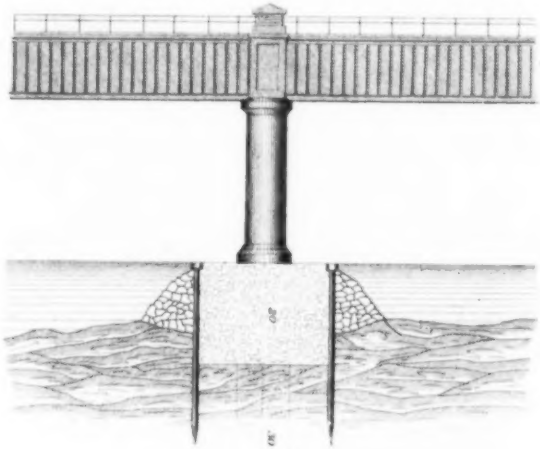
The continental engineers having put down a good many foundations by this process of late years, a description of a few of their works may be more interesting than that of the better known English examples.

*Mâcon Bridge.*—At the Mâcon bridge, over the Saône, in France, instead of masonry piers, the cast iron cylinders were carried up to the bridge seat. Plate No. 1 gives a side and an end view of the pier. Three cast iron columns, ten feet in diameter, and one and a half inches thick, placed thirteen feet between centres, were sunk from thirty-two to forty-feet in the soil, to a depth of fifty feet below low water. Above this they are surmounted with smaller tubes eight feet three inches in diameter, joined with the foundation tubes by a conical base, and carried up thirty-three feet above low water. The whole foundation is protected from injury by a mass of concrete nineteen and a half feet thick, inclosed in sheet piling; and above this the tubes are thoroughly braced together. The columns are filled to the top with concrete, which is capped with cut stone

## Pier of Mâcon Bridge over the Saone.



End view



Side view

to receive the bearing plates of the trusses. The bridge consisting of boiler plate girders for double tracks, the centre column carries two trusses, and the outside, one truss each.

The main difficulty met with in the execution of this work, which was carried on in a comparatively tranquil river, seems to have been in apportioning at all times the weight, to the friction of the tube against the soil and the reaction of the compressed air. Sometimes no amount of weight could start the column for a while, when it would suddenly go down several feet. At other times the buoyancy of the air would drive the column up, and pressure had to be diminished.

One of these columns having been broken by the shock of a passing boat, engineers have since generally adopted a greater thickness than one and a half inches, for all parts exposed to similar accidents.

Similar foundations were put in for a bridge over the same river at Lyons.

*Theiss Bridge.*—At the bridge over the Theiss, at Szégédin, in Hungary, built by M. Cézanne in 1858, the very bold expedient was adopted of putting down columns of the same dimensions as those at the Mâcon bridge, to carry a series of wrought iron arches of 136 feet span for a double track railway bridge.

The piers consist of two columns, each ten feet in diameter, placed thirteen feet between centres, the centre of each column coinciding with that of the track it carries. They are sunk to a depth of thirty-nine feet below low water, or about twenty-nine feet through the soil. After the tubes were sunk by the plenum process to the desired depth, wooden piles were driven inside of them, to a further depth of twenty feet, to consolidate the bottom, and support the concrete, with which they were filled up to low water.

As it would have been difficult to make a satisfactory connection between the tubes and the arches, they were surmounted above low water with a square shell of wrought iron, thoroughly braced and filled in with masonry, which receives the springing of the arches.

The foundation columns are protected by a timber ice breaker, and are surrounded by concrete and rip rap enclosed in sheet piling.

In order to relieve the piers as much as possible from the thrust of the arches, the square wrought iron portion of the tubes is carried up as high as the crown of the arches, and connected with a horizontal chord extending the whole length of the bridge.

It is found, however, that the passage of a train springs the tops of the columns, as the load successively rests upon each span, and that variations of temperature produce deformations of the piers and of the arches at the springing, so that the permanent stability of this work has been questioned.

*Bordeaux Bridge.*—The method of sinking all these tubes, was that of suddenly restoring gravity to the column, by allowing the compressed air to escape, after having excavated inside as deep as possible, and loaded the tube on top to overcome the adhesion of the soil. This process, however, results in a series of rapid descents or jumps, during which it is difficult to keep the column vertical; the staging occasionally proving insufficient to prevent lurches and settling out of line of the tube. At the Theiss bridge, it was found necessary on one occasion to unload and raise a tube several feet, in order to restore it to the proper line, while the scour of the soil and water under the lower edge, as they rushed into the column at each sinking, loosened and disturbed the adjoining tube, and considerably increased the cubic contents to be removed.

In order to avoid these difficulties, at the bridge of Bordeaux, over the Garonne, built in 1859 and 1860, by Messrs. Bommart and Surrel, engineers, the tubes were forced down without intermitting the air plenum, by hydraulic presses erected upon the staging.

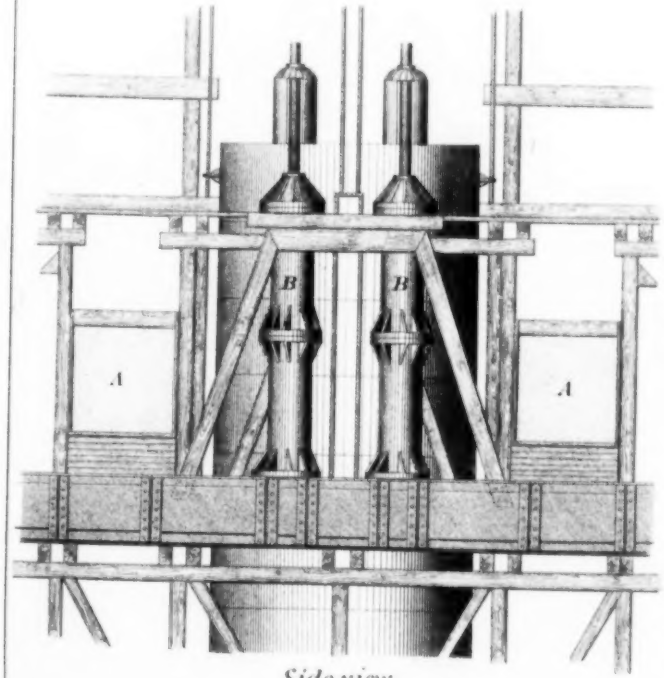
Plate II. shows the process adopted. The piers are composed of two cast iron columns, each eleven feet nine inches diameter, throughout their whole height, and sunk to a depth of fifty-two feet below low water. They are formed of a series of full cylinder sections, each four feet eight inches high and one and a half inches thick, bolted together through inside flanges, and filled with concrete.

The columns are united by strong diagonal bracing, and carry a double track railway bridge on two trusses. It was at first intended to protect them from shocks of passing boats, by iron starlings resting upon smaller columns above the main pier, but these were omitted in the execution of the works.

In order to sink the tubes, sufficient weight was placed in ballast boxes, resting on the staging, as shown at AA., to overcome both the friction of the soil, and the buoyancy of the compressed air. Four hydraulic presses, BB, were suspended in pairs on each side of the tube, by cross girders resting upon its top section, and were connected with the ballast boxes below.

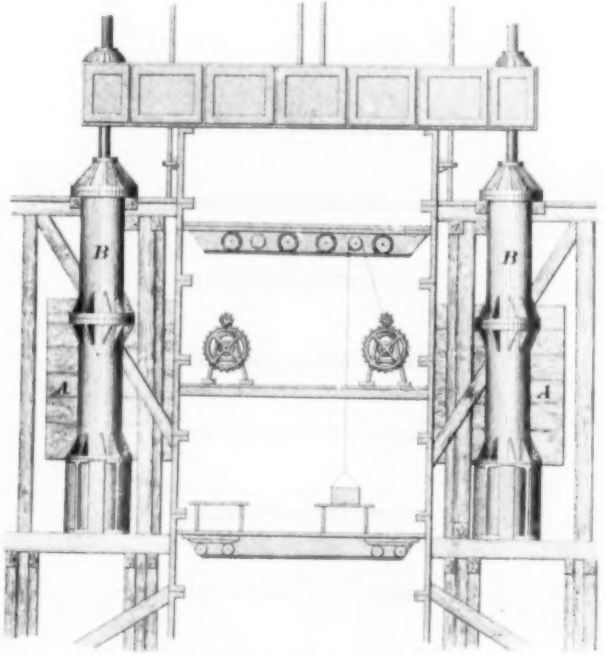
By working the pistons of the hydraulic presses, they tended to

# Bordeaux Bridge




Side view

Method of Sinking tubes




Section through tube

lift the ballast boxes from the staging, and transferred their weight to the tubes, and by operating with either one or both pairs of presses, the exact weight required at each stage of the operation was obtained, and the column put down as fast as the material was excavated inside, without intermitting the plenum or allowing the compressed air to escape.

This modification, which secured perfectly vertical and nearly a uniform rate of descent, is, however, not only more expensive than the ordinary method of intermitting the air pressure, but also compels loading the tube with much greater weights, in order to overcome the reaction of the compressed air, as well as the friction of the tube; and these great loads upon the empty shell, may cause fracture. On one occasion, one of the sections of the tube composing the air-lock, and one and a half inches thick, burst, and the fragments were projected outward by the air pressure.

On another occasion, one of the tubes which was in process of sinking, broke from its fastenings to the hydraulic presses, and was raised by the reaction of the air fifteen or twenty feet.

There are at this bridge six piers, each formed of two columns spaced twenty-six feet three inches between centres, and the sinking of these twelve tubes occupied thirteen months, while the whole structure occupied twenty-three months in building; this time being nearly an average of that occupied by recent works of this character in Europe.

*Saltash Bridge.*—We translate the following from M. Perdonnet's work upon "Railways." "The sole pier of the Saltash bridge was founded upon a rock at a depth of eighty-two feet below high tide, covered with seventeen feet of soft mud. Mr. Brunel decided to build a sheet iron cylinder eighty-eight feet in average height, so as to project six feet above high tides. The rock, however, sloped, so that it was necessary to cut the base of the cylinder off at an angle, and fit it to the shape of the rock as near as possible.

The cylinder was thirty-five feet in diameter at the bottom, and so constructed that the pier could be built inside of it up to the water-line; above this, it was to be surmounted with four cast iron columns, carrying the trusses of the bridge, which are each of 455 feet span. The problem, therefore, was how to ground the cylinder, to fit it accurately to the rock so as to shut out the mud, and how afterwards to clean it out and build inside as in a coffer-dam.

(To be continued.)

## PECULIARITIES OF THE LINK MOTION.

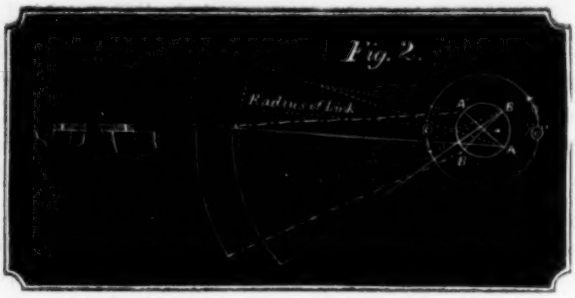
By A. Dunbar, Second Assistant Engineer U. S. N.

The link motion, as applied to a numerous class of engines for screw vessels in the Navy, is the type upon which the following deductions are based:

To render them more simple, they will be divided into four parts, viz.:—*First*, Radius of Link. *Second*, Variation of Lead. *Third*, Point of Suspension. *Fourth*, Effect of the point of attachment of the excentric rods to the link upon the point of cutting off.

*First.* The radius of the link is correct, when the lead increases or decreases equally upon both ends of the stroke throughout the movement of the link. With the dimensions commonly used, it is the distance from the centre of the link-block to the centre of the excentric, less three quarters of the lap and lead of the valve. Reference to this will be made in the second part of this paper, in order to dispense with a diagram to illustrate this point.

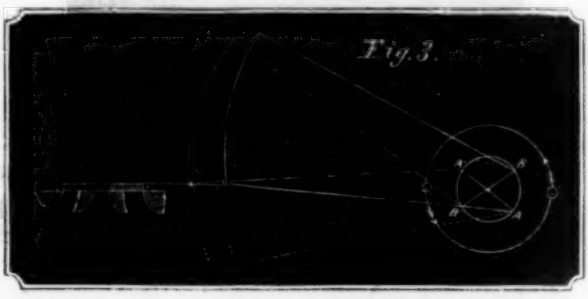
*Second.* The lead increases, when the link is moved from full gear into mid gear, if the excentric rods are *crossed*, when the crank is on the centre next to the cylinder, and decreases, if they are *not crossed* under the same circumstances.




In Fig. 2, A and B, are the positions of the centres of the forward and back motion excentrics, when the crank is on the centre, C, next to the cylinder. The direction in which the crank moves forward, is indicated by the arrows.

The full lines represent the position of the excentric rods and link, in full gear forward motion, crank on centre, C, and the broken lines, the position of the same in mid gear, crank on centre, C. By inspection, it will be seen, that when the link is drawn up into mid gear, the valve has opened the outboard port, and increased

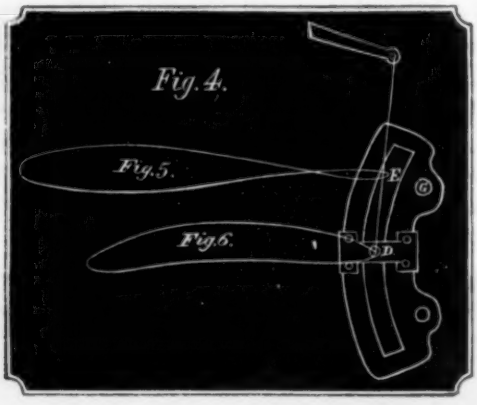
the lead equal to the distance, x. In these diagrams, the valve is supposed to be without lead, when the link is in full gear. The uneven broken lines represent the position of the excentric rods and link in full gear, forward motion, crank on centre, c′, and the even broken lines, the position of the same in mid gear, crank on centre, c′. By inspection, it will be seen, that when the link is drawn up into mid gear, the valve has opened the inboard port, and increased the lead equal to the distance, x′; as x and x′, are equal, the radius of the link, is correct. If they were not equal, it would be necessary to divide the difference, and through that point and the extremities of the link, draw a curve, the radius of which will be the true radius for the link.



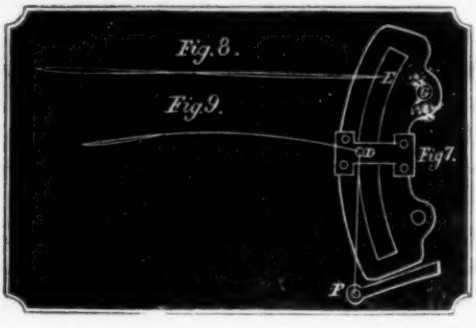

In Fig. 3, A and B, are the positions of the centres of the forward and back motion excentrics, when the crank is on the centre, c. The full lines represent the position of the excentric rods and link in full gear, forward motion, crank on centre, c, and the broken lines, the position of the same in mid gear, crank on centre, c. When the link is lowered into mid gear, it will be seen, that the valve has moved over the outboard port, and the lead is a negative quantity equal to the distance, x. The uneven broken lines represent the position of the link and excentric rods in full gear, forward motion, crank on centre, c′, and the even broken lines, the position of the same in mid gear, crank on centre, c′. As on the other centre, when the link is lowered into mid gear, the valve has moved over the inboard port, and the lead is a negative quantity equal to the distance, x′.

In Fig. 2, the excentric rods are *crossed* at o, when the crank is on the centre next to the cylinder, and in Fig. 3, they are not *crossed.*

*Third.* The point of suspension should be so arranged, that the slip upon the link-block should be the least obtainable in practice, that the wear upon these parts may be as slight as possible, for they are generally so constructed, that the lost motion in these parts can only be taken up by substituting a new block.




If the point, D, (Fig. 4,) moves in an arc whose concave side is up, as is ordinarily the case, and as there represented, the point, E, will, if the drawing be enlarged eight times, develop a figure as shown at Fig. 5. If the point, E, moves in a straight line without slip upon the block throughout a revolution of the crank, a figure will be developed by the point, D, as shown at Fig. 6 (enlarged as before). If the point, D, Fig. 7, be moved outboard upon the link-saddle, about three-quarters of the lap and lead of the valve, it




will then develop, if the point, E, moves in a straight line, and the drawing be enlarged as before, a figure as shown at Fig. 9. This figure is very nearly the arc of a circle.

Find the centre of the arc that nearest approximates this figure, and we have the position of the extremity of the reversing arm, and the length of the suspension rod.

If the point, D, moves in that approximate arc, the point, E, will develop a figure as shown at Fig. 8. As the convex side of Fig. 9 is up, the extremity of the reversing arm must be below the link, and almost under the point, D, vertically.

With these points in this position, the slip of the link upon the block, will not exceed one-fortieth the travel of the valve. The distance the point, D, has to be moved outboard upon the link-saddle varies with every variation of the length of the link compared to the travel, and lap and lead of the valve. The author is unable to give any rule for finding this point that he can rely on in all cases. To explain the process for laying down the figure shown at Fig. 6, would extend this paper beyond its intended limit. The distance is determined from the shape of this figure, and this varies with every change in the dimensions. Those given here are for the general proportion of the "Juniata" class of engines. The slip increases as the link is moved either way from the given position, and these points should be located for the position in which the link is mostly used. The extremity of the reversing arm must be in the centre of the approximate arc, for if this point does not coincide with that centre, the slip is materially increased.

*Fourth.* In engines using a slide-valve with lap and lead, the point of cutting off is generally unequal if the lead is equal, owing to the angularity of the connecting rod. If the excentric rods are attached to the link at a point inboard from the centre of the

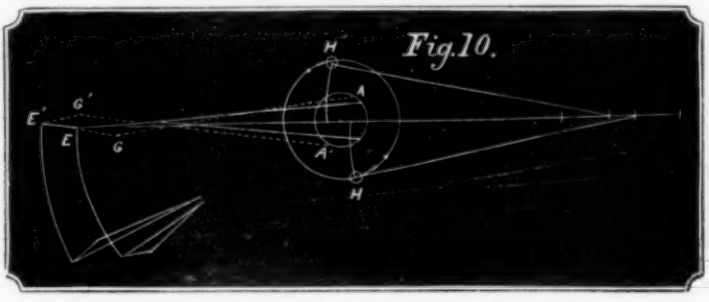


*Fig. 10.*

curvature of the link, as at G, Fig. 4, and the engine be back-acting, this arrangement will equalize the point of cutting off, provided the point, G, be the proper distance from the centre of the link-

block. To illustrate this, reference will be made to Fig. 10. Suppose the point of cutting off, to be at six-tenths the stroke, and the length of the connecting rod to be two and one-half times the stroke of the piston, then the crank will stand at the point, H, when cutting off on the outboard end, and at H′, when cutting off on the inboard end of the cylinder.

The crank has moved through more than six-tenths of a semi-revolution, when it arrives at H, and as the valve moves with the crank, the valve would be more than closed, were it not for the angle, E, G, A, formed by the link and excentric rods at this time, which angle shortens the distance from E to A, and prevents the valve from closing until the crank arrives at H.

Again, when the crank arrives at H′, it has not completed six-tenths of a semi-revolution, and the valve would not have closed, were it not for the angle, E′, G′, A′, formed by the link and excentric rods at this time, which angle shortens the distance from E′ to A′, and closes the valve when the crank arrives at H′. (The point of cutting off, on the "Juniata's" engines, is within an eighth of an inch of being equal.) With the valve attached to the link, and moving coincident with it, if the engine was direct-acting, the difference in the point of cutting off would be nearly doubled; but if a rocker-shaft be interposed between the link and valve, the difference is equalized.

In the preceding parts of this paper, this peculiarity of the link motion was not taken into consideration, because the back motion, excentric rod, and end of the link makes nearly the same angle as the forward motion, at the same time, and the result is to draw the link bodily inboard, and does not materially affect the deductions then stated.

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## A. F. BALLAS' PATENT R. R. SWITCH.

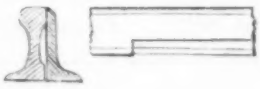
THE many accidents which occur through the switches now in use, leave no doubt that they are highly defective and dangerous. The principal objections against them are—

1st. When the switch is set for the side track, the main track is interrupted. Thus, if a switch has been left standing for the side track by the switch-tender, trains which follow the main track will be thrown from the rails.

2d. Every change in the connection of the tracks through the switch, has to be made by the switch-tender; or in other words, the switch is not self-acting.

All inventors who devised improvements in railroad switches, paid especial attention to these two points; their object was to construct a self-acting safety-switch. The best self-acting safety-switch I know, is in use on many of the European railroads, and is patented in the United States by Withcomb. C D and C′ D′ are tongues or

movable switch-rails connected together by cross-rods. The end of the tongue is made wedge-shape, and adapted to fit into a notch in the side of the rail. In order to avoid strong concussions at the point of the tongue, the flanges of the wheels are guided by guard-rails on the side of the track opposite to the point of tongue. The tongues are always kept pressing against one side of the track through a lever with counter-weight, arranged in such a manner that the switch stands always for the main track. When a train is to pass from the main track to the side branch, the tongues must be pushed to the opposite side by the switch-tender through the lever; but when the train runs from the side branch to the main track, the tongues are pushed towards the opposite side by the flanges of the wheels, and go back to their old position by the action of the counter-weight, as soon as the train has passed.



These switches have undoubtedly great merits in regard to safety and automatic action, nevertheless they have not been used much in this country, and I think for these reasons: the end of the tongue is of the same height as the rail, and presents a very thin or narrow edge to the tread of the wheel, and is therefore liable to be crushed and destroyed by heavily laden trains, while the notches in the rails to receive the ends of the tongues, weaken said rail in a great degree. Then the switch is self-acting only in *one* direction. The improvements of my switch over that of Withcomb, consist—

1st. In the shape of the tongues. The rails against which they set are *not notched*, but are preserved complete, as shown by sections A, B and C′. The end of the tongue is constructed lower than the rail, and is adapted to fit snugly against the web and the under side

of the tread; by these means the tongue has no weight to carry at its weakest place (from A to B), and suffers no concussion, but merely has to resist the side pressure of the flange of the wheel; it begins to carry the load of the train at B, where its tread is $1\frac{1}{8}$ inches.

2d. In the arrangement of the switch-stand and counter-weight. The counter-weight, A, is applied to one end of a rod that at its inner end is hung so as to turn upon an axle between two plates, which hang loose on the same axle. Between these plates, B, little stop-blocks for the weight-arm to rest upon; their lower end is connected through a rod, with the switch-tongues. Having the arm of the counter-weight resting on one of the stop-blocks, as shown in Fig. 2, the switch is acting in the same way as Withcomb's; trains will follow the main track in both directions, up and down, and pass from the side branch to the main track, without any assistance of the switch-tender. Turning the weight over and having it resting on the other stop-block, the switch is in the position shown by Fig. 1. In this position trains pass from the main track to the side branch, from the side branch to the main track, and can follow the main track in the direction of the arrow, without any assistance of the switch-tender. This double action of the counter-weight gives great facilities for shifting trains, and is especially of importance for railroads with one single track.

As soon as the counter-weight is turned over, a target, suitably connected with its axle through pinion-wheels, will revolve, and shows a white or other surface or light, as may be arranged or agreed upon, and thus indicate the engineer of the train how the switch is set.

Guard rails are not required for this switch.

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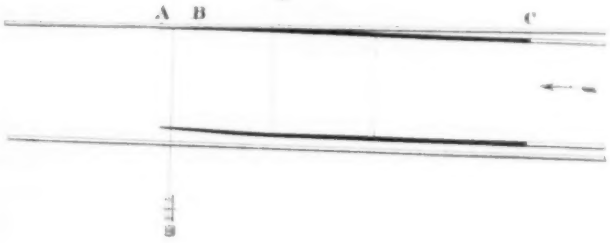
## AIR GUN.

It is curious to notice the manner in which improvements sometimes retrace their steps, and return to old and abandoned fields.

Thus, gunpowder was undoubtedly far in advance of any other means devised for giving motion to projectiles; but yet, the new conditions introduced in modern warlike practice, render its violence of action too destructive to the ordinance employed, when this is of great calibre, and some modification is demanded, by which a more gentle persuasive than even mammoth powder or powder-cakes,

## A. F. BALLAS' PATENT R.R. SWITCH.

Fig 1.



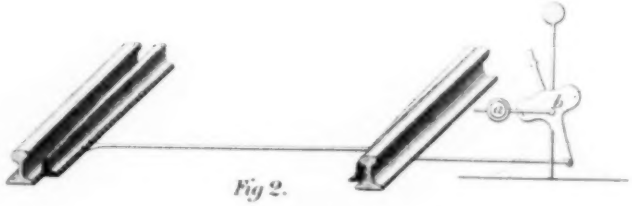
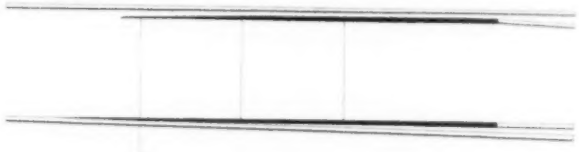




Fig 2.



*Sections of Tongue and Rail.*

may be applied to the enormous shot of 1000 or 6000 pounds, which it is now deemed advisable to hurl at an iron-cased enemy.

In a late number of *Engineering*, we find an interesting paper illustrating our remarks, a detailed account of which, we believe will be of interest to our readers.

Although with the use of gunpowder, good strong guns may be, and are made up to calibres of 15 inches, and even 20 inches; all our skill has been unable to make a trustworthy rifled gun of even 13·3 in. bore to throw a 600 lb. shot.

An enormous air gun of 32 in. bore has lately been invented, to throw a 600 lb. shot. The bore of the gun is to be upwards 30 ft. long, and the air compressed and retained at a working pressure of 10,000 lb. per square inch. The sectional area of a 32 in. bore is 804¼ square inches, and the total initial pressure would thus be 8,042,400 lb., or nearly 3600 tons. It would, of course, be next to impossible to pump in air fast enough at this enormous pressure to keep up the velocity of the shot, so the high pressure air is to be contained in a huge casing or jacket formed around the bore of the gun, and having the same capacity of say, 165 cubic feet. Thus, instead of the pressure being reduced almost to *nil* at the muzzle, the air would have been expanded but twofold on the discharge of the shot; and if we disregard the influence of rarefaction, and consequent cooling by expansion, and its effect on the pressure, we should have 5000 lb. per square inch still left. If we take the average pressure at 7500 lb. throughout the length of the bore, we shall have 2400 tons exerted through 30 ft., or say 72,000 foot tons, and this, were the air to follow fast enough, would send a 6000 lb. shot at a rate of more than 1300 ft. per second. As no ordinary valve could be opened quickly enough to admit air under such pressures, and in such quantities, the shot itself forms the valve. The high pressure air in the air casing or jacket enters the chamber of the gun through ports, like those by which steam enters a steam cylinder. The shot—a short cylinder with hemispherical or pointed ends—is so packed as to close these ports while the jacket is being pumped full. To discharge the gun a little high pressure air is separately pumped in behind the shot, so as to start it on and past the ports, when the stored-up air does the rest of the work.

Although there may be certain practical difficulties in carrying out this scheme, it possesses great interest, and we shall look with much curiosity to its practical realization.

# Mechanics, Physics and Chemistry.

## LECTURE-NOTES ON PHYSICS.

By Prof. Alfred M. Mayer, Ph.D.

(Continued from page 335.)

### 7. *Porosity.*

The spaces which exist between the ultimate parts of bodies—that is, between their atoms and between their molecules—are called *pores;* by virtue of which all bodies have porosity.

This property is a natural deduction from the properties of compressibility and dilatability; for all bodies can be reduced in volume by pressure, and this reduction of volume is only limited by the pressures which our machines can produce, and all bodies expand in volume when relieved of pressure; we therefore conclude that the ultimate parts of bodies do not touch, but are separated by intervals that we call pores.

This property of porosity, first indicated and concisely defined by Gassendi, can, however, be directly proved by numerous experiments.

Porosity of solids. Water and oil have, by enormous pressures, been forced through the walls of vessels of gold and of iron; iron converted into steel by absorbing carbon at a high temperature; gold and the densest bodies are transparent when reduced to sufficiently thin leaves; lead is so porous to mercury, that Prof. Henry made a syphon of a solid bar of lead draw mercury over the side of a vessel containing it; marble and all rocks are porous to gases, allowing them to "diffuse" through them. We can ascertain how a stone will be affected by frost, by allowing it first to absorb a solution of sulphate of soda, and then ascertaining the effects produced by its subsequent crystallization. It is better, however, to determine directly the effect of the freezing of absorbed water. See *Smithsonian Report*, 1857, p. 305. (It is probable that the two preceding instances are examples of the porosity existing between the integral crystals of the stone and not between the ultimate parts, and therefore is not porosity in the sense in which we have defined it.) Hydrophane, a species of agate, becomes translucent by the

absorption of water, when immersed in that liquid, while the displaced air issues from the hydrophane in minute bubbles.

M. M. Deville and Troost have recently shown that platinum and other dense metals and cast iron, when heated to redness, are porous to gases. The injury to health produced by heating dwellings by means of cast iron stoves, is caused by the vitiation of the atmosphere by the gases of combustion transmitted through the hot iron. (See *Comptes Rendus*, Jan. 20, 1868. Report of commission on the observations of Dr. Carret, on the deleterious effects of cast iron stoves.)

Porosity of Liquids. If measured volumes of water and of alcohol are mixed, it is found that their combined volume is less than the sum of their volumes before mixing. The greatest contraction takes place when 100 volumes of water are combined with 116 volumes of anhydrous alcohol, the diminution in volume being equal to 3·7 per cent.

This experiment, due to Réaumur, is made as follows: to a bottle is adapted a deeply fitting cork, perforated by a glass tube. The requisite proportion of water is placed in the bottle, and on this, colored alcohol is gently poured until it completely fills the bottle. The stopper is now forced in, and the alcohol rises in the glass tube. The height of the liquid is marked, and the bottle being so inclined that the mixture of the liquids takes place, the fluids contract, and the alcohol descends in the tube.

Contraction also takes place when water is mixed with sulphuric acid, with salt and with other substances. No experiment could more clearly show that the atoms of water and alcohol do not really fill the space which the liquids appear to occupy.

Water and other liquids dissolve gases; for example, 1 volume of water at 60° Fah. will dissolve 720 volumes of ammonia, and increase in its volume only one-half, and in its weight one-third.

Porosity of gases. Six parts by weight of carbon will unite with eight parts by weight of oxygen, and yet the resulting carbonic acid gas has the volume of the oxygen before combination.

Air and vapor are porous to each other, and between the atoms of air there may exist the ultimate parts of other gases.

It is to be remarked that this property of porosity is not opposed to the property of impenetrability, for it is the atoms which are

impenetrable, while it is the intermolecular spaces of one body which are penetrated by the atoms of another.

We must be careful not to confound the true meaning of porosity, as given above, with what we designate as *organic*, or *structural porosity*. Organic pores are interstices which are visible with the aid of the microscope, and often even with the naked eye, while the intermolecular spaces are invisible by any means.

Examples of organic porosity. Mercury forced through wood. Circulation of sap in plants.

Examples of structural porosity. Porosity of stones, caused by the minute interstices produced by the crystalline structure of the stone. Paper used to filter liquids.

### 8. *Mobility.*

Everywhere in the universe, we see masses of matter changing their positions with reference to each other; while others appear to be at rest.

We only know that a body changes its position by referring it to other bodies, supposed to be at rest; and therefore Descartes defined motion as a rectilinear change of distance between two points. From this definition, if only one point existed in the universe, its conditions, whether of rest or of motion, could not be determined.

If the points to which we refer the moving body be really at rest, then the successive varying measures give us the *absolute motion*, but if this point be only apparently at rest, we obtain the *relative motion*. Give illustrations.

Rest is however only *apparent*; we know of no point in the universe which is absolutely at rest; therefore all the motions which we have determined are relative.

All bodies on the surface of the earth have the relative positions of their atoms changed by every change of temperature, by every vibration which they transmit; they are in motion with the earth on its axis and in its orbit, while the earth with the planets and sun are being translated in an unknown path in space. The stars, improperly called *fixed*, have also motions of their own, which, in some cases, are evidently of great magnitude.

Kind of motions. A motion may be one of *translation*, of *rotation*

round an axis, or of a combination of these motions; it may be *rectilinear* or *curvilinear*, *continued* or *reciprocating*. Give illustrations.

The line a point of a body describes in space, is called its *trajectory*.

The *velocity* of motion of a moving body, or the ratio of the space described to the time of describing it, may be *uniform*, *uniformly accelerated*, *uniformly retarded*, or *irregular*.

*Uniform motion* is that in which equal spaces are passed over in equal, small portions of time.

Formulæ of uniform motion.

$$(1) \quad s = v\,t; \quad t = s\frac{s}{v}; \quad v = \frac{s}{t}$$

in which $s$ = space described; $v$ = velocity of moving body, or the space described in unit of time; $t$ = time occupied in going over space $s$.

*Uniformly varied motion* is that in which the change in velocity at the end of a certain time, is proportional to this time.

Let $u$ be the initial velocity of the body, that is to say, the velocity at a given instant from which we commence to reckon the time; $a$ the acceleration, or the constant quantity by which the velocity varies in a unit of time; $v$ the velocity at the end of $t$ seconds; we have from definition of uniformly varied motion.

$$(2) \quad v = u \pm a\,t$$

The sign + when the motion is accelerated; the sign — when it is retarded. In the last case, the velocity will become 0 when $u = a\,t$, that is to say, at the end of a number of seconds represented by $u : a$.

If, in formula (2), we make $u = 0$, then the moving body starts from a state of rest, and we have at the end of time $t$

$$(3) \quad v = a\,t;$$

that is, *the velocity acquired at the end of a certain time is proportional to this time.*

*In uniformly accelerated motion, the spaces described by a body starting from a state of rest, are proportional to the squares of the times employed to describe them;* or—

$$(4) \quad s = \tfrac{1}{2}\,a\,t^2$$

which shows that the space gone over in uniformly accelerated

motion, by a body which starts from a state of rest, is equal to the space which it would go over with a *uniform motion* with the velocity $\frac{1}{2} v$ or $\frac{1}{2} a t$.

It is often required to know the velocity acquired in function of the space gone over. We obtain this by eliminating $t$ in the two equations $v = a t$, $s = \frac{1}{2} a t^2$, which gives—

$$(5) \quad v = \sqrt{2 a s}$$

A body falling vertically, in vacuo, by the action of gravity, from a height which is exceedingly small compared with the radius of the earth, may be regarded as having a uniformly accelerated motion. In this case $a$ is equal to the velocity acquired by the body at the end of the first second of its fall. This velocity which is the measure of the intensity of gravity, and which is equal, in the latitude of New York, to 32 feet 2 inches, is always indicated by the letter $g$. The formula (5) then becomes—

$$v = \sqrt{2 g s}$$

*Problem.* What velocity will a body acquire by falling 772 feet, in the latitude of New York? Ans. 222 feet, 10·28 inches.

When the moving body possesses an initial velocity $u$, at the moment from which we count the time, the above formulæ become—

$$v = u + a t; \; s = u t + \tfrac{1}{2} a t^2, \; v = \sqrt{u^2 + 2 a s}$$

To Galileo is due the discovery of the laws of uniformly varied motion. Give his classical demonstration of these laws.

*Co-existence of separate motions.* When a body in motion is acted on by a force, the same effect in motion is produced as if that force moved the body from a state of rest. Thus, a cannon ball projected horizontally from an elevation, will reach the ground by the action of gravity, in the same time (assuming that no air resists its motion) as if it dropped vertically from the elevation through the same height.

"A body describes the diagonal of a parallelogram by two forces acting conjointly, in the same time in which it would describe its sides by the same forces acting separately."—*Newton.*

The discovery of the law of the co-existence of motions, is also generally ascribed to Galileo (Dial. 4, Prop. 2), but Aristotle clearly announced it in his Mechanical Problems, c. 24.

The various relations of space and time can readily be represented geometrically, by making lengths of ordinates stand for velocities acquired at the end of times represented by lengths of abscissas. Thus, uniformly varied motion is represented by a right angled triangle, whose base equals in units of length the units of time during which the motion took place, its altitude, the velocity acquired at the end of this time, while the units of area of the triangle represents the distance gone through by the moving body.

The consideration of motions, irrespective of force and of the properties of matter, constitutes the part of science called *Kinematics.* (Gr. Κινησις, motion.) The ablest discussion of this subject is found in first chapter of the *Natural Philosophy*, by Profs. Thomson and Tait, Oxford, 1867.

(To be continued.)

## FLAME REACTIONS.

By Prof. Bunsen.

Translated by Prof. Charles F. Himes, Ph. D., Dickinson College, Carlisle, Pa.

(Concluded from page 344.)

It would lead us too far to follow the special processes which would occur upon treating more or less complex mixtures, according to the preceding experiments. It may be sufficient, therefore, to show the advantages of the methods described by a few small examples.

1. *A mixture of sulphide of arsenic, sulphide of antimony, and sulphide of tin.*

If these three sulphur compounds, extracted according to the usual course of qualitative analysis by means of alkaline sulphides and re-precipitated by acids, contain only traces of antimony and tin, the detection of the last two metals according to former methods, as is well known, is excessively tedious and uncertain. In the following way they can be detected easily, and with certainty, even if the quantity of tin only amounts to several thousandths, and that of antimony to a few hundredths of the mixture.

About three decigrammes of the sulphur compounds are roasted upon a fragment of glass,* small enough to be completely enveloped by the flame, and the few milligrammes of residue are scraped together with a knife, the moistened mass is spread upon the end of a fibre of asbestus, and a strong metallic incrustation is produced from it on a test-tube. In order to avoid a deposit of some carbon at the same time, which would impair the subsequent operations, the upper reducing flame is made so slight, that it is scarcely recognizable as a luminous point. After the incrustation has been dissolved in a few drops of nitric acid in the marginal depression of the lamp-plate, Fig. 3, the solution is evaporated, below its boiling point, by warming and blowing upon it, whereby it is concentrated upon the smallest possible space. If a drop of perfectly neutral silver solution is dropped upon the residue from the solution, just at the instant at which it appears dry, the characteristic black spot of antimonate of sub-oxide of silver forms by blowing ammonia upon it and moistening it with it, and the reaction of arsenic also usually manifests itself.

In order to detect tin, a few scarcely visible particles of the roasted sulphur compounds are fused in the upper reducing flame with a borax bead, *scarcely perceptibly* colored by oxide of copper. If the bead is placed in the lower reducing flame, it becomes ruby-red by reason of sub-oxide of copper formed; if it becomes bright-brown, blackish-brown, and opaque by reason of too copiously separated sub-oxide, it is only necessary to move it back and forth in the upper oxidizing flame for some time, and from time to time to hold it up to the light, in order to obtain the ruby-red, transparent glass, which can be destroyed in the oxidizing flame, and restored in the reducing flame, as often as desired in the way described. This reaction for tin can only be produced in the lower reducing flame of the non-luminous gas lamp, and not with the blow-pipe, since by means of the latter the oxide of copper may be reduced to sub-oxide without tin.

2. *Foliated tellurium* (*Blättererz*), *containing tellurium, selenium, antimony, lead, gold, and sulphur.*

After the sulphur has been recognized upon heating by its odor,

* Pieces of a thin, chemical flask are also best for use in this case.

a metallic incrustation is next produced upon a test-tube, and a few drops of *concentrated* sulphuric acid are placed in another test-tube, only a little wider and somewhat shorter, and the former is so depressed into the latter that the metallic incrustation may be surrounded by sulphuric acid. Upon warming, with *slowly* increasing temperature, the selenium manifests itself at once by an intense carmine color of the sulphuric acid. If the temperature is raised to the boiling point of sulphuric acid, the dissolved tellurium is first oxidized; the red color of the acid yields to a muddy-green of the dissolved selenium; the cooled solution does not now become black from tellurium, but weak yellowish-red from separated selenium, which, if only traces of it are present, is most clearly recognized by looking from above into the mouth of the test-tube held above white paper. Since commercial sulphuric acid often contains traces of selenium, it is advisable to render certain its absence from the acid to be used by means of a test experiment.

The antimony of the blättererz can be recognized by the method given in the previous example. In order to detect the lead and gold, a test-specimen is reduced on a charcoal rod, and the lead, containing the gold, is rinsed upon a flat piece of glass, and the dried metallic spangles are treated with moderately concentrated nitric acid as long as any portion dissolves. The acid is then evaporated, and the residue dissolved in a few milligrammes of water. The solution, placed by means of a capillary pipette upon another capsule, gives the characteristic precipitate of sulphate of lead, when treated with a few milligrammes of sulphuric acid. The gold, which separates upon solution of the lead as a brown powder, is thoroughly washed, by repeatedly pouring water upon it and taking it up again with a pipette. A portion of the dried particles of gold is fused on a charcoal rod with carbonate of soda, and obtained as gold-lustred spangles upon trituration in an agate mortar. The other portion is tested with hydrochloric acid, in which it is insoluble, is dissolved by addition of nitric acid, and after evaporation is tested for gold by proto-chloride of tin. A centigramme of the test-specimen, containing only a few tenths of a milligramme of gold, is sufficient in experienced hands for all these reactions.

VOLATILE ELEMENTS, SEPARABLE BY

| | Metallic Incrustation and Coating. | Oxide Incrustation and Coating. | Oxide Incrustation with $SnCl$. | Oxide Incrustation with $Sn\,Cl$ and $Na\,O,\,HO$. | Oxide Incrustation with $Ag\,O$, $NO_5$ and $NH_3$. |
|---|---|---|---|---|---|
| Te, | Black, with brown coating. | White. | Black. | Black. | White into yellowish. |
| Se, | Cherry red, with brick-red coating. | White. | Brick-red. | Black. | White. |
| Sb, | Black, with brown coating. | White. | White. | White. | Black; insoluble in $NH_3$ |
| As, | Black, with brown coating. | White. | White. | White. | Lemon-yellow or brownish-red; soluble in $NH_3$ |
| Bi, | Black, with soot-brown coating. | Yellowish-white. | White. | Black. | White. |
| Hg, | Gray, incoherent coating. | | | | |
| Tl, | Black, with brown coating. | White. | White. | White. | White. |
| Pb, | Black, with brown coating. | Bright ochre-yellow. | White. | White. | White. |
| Cd, | Black, with brown coating. | Black into brown, with white coating. | White. | White. | White coating, becomes blue-black. |
| Zn, | Black, with brown coating. | White. | White. | White. | White. |
| Sn, | Black, with brown coating. | Yellowish-white. | White. | White. | White. |

## REDUCTION AS INCRUSTATIONS.

| Iodide Incrustation and Coating. | Iodide Incrustation with $NH_3$ (blown upon it.) | Sulphide Incrustation and Coating. | Sulphide Incrustation with $NH_4S$. | |
|---|---|---|---|---|
| Brown, breathed upon disappears transitorily. | Disappears permanently. | Black to blackish-brown. | Disappears transitorily. | |
| Brown, breathed upon does not wholly disappear. | Does not disappear. | Yellow to orange. | Orange, then disappears transitorily. | Substances, the metallic incrustations of which are scarcely soluble in dilute nitric acid. |
| Orange-red, breathed upon disappears transitorily through yellow. | Disappears permanently. | Orange. | Disappears transitorily. | |
| Egg-yellow, breathed upon disappears transitorily. | Disappears permanently. | Lemon-yellow. | Disappears transitorily. | |
| Bluish-brown, with flesh to aurora-red coating. breathed upon disappears transitorily. | Aurora-red to egg-yellow, chestnut-brown when blown dry. | Umber-brown, with coffee-brown coating. | Does not disappear. | |
| Carmine and lemon-yellow, breathed upon does not disappear. | Disappears transitorily. | Black. | Does not disappear. | Substances, the metallic incrustations of which are difficultly soluble in dilute nitric acid. |
| Lemon-yellow, breathed upon does not disappear. | Does not disappear. | Black, with bluish-gray coating. | Does not disappear. | |
| Egg-yellow to lemon-yellow, breathed upon does not disappear. | Disappears transitorily. | Through brownish-red into black. | Does not disappear. | |
| White. | White. | Lemon-yellow. | Does not disappear. | Substances, the metallic incrustations of which are instantly soluble in dilute nitric acid. |
| White. | White. | White. | Does not disappear. | |
| Yellowish-white. | Yellowish-white. | White. | Does not disappear. | |

## PATENTING A PRINCIPLE.

(Continued from page 340.)

THE minority put a different construction upon the grant. They held that it appropriated the newly discovered property of lead, and that the plaintiff had a right to so appropriate it, and ought to recover. Lord HOPE'S views were greatly relied upon, and it was evidently supposed that they had been sanctioned by the House of Lords. It should be observed, further, in order that the bearing of this case may be fully understood, that, in O'Reilly *v.* Morse (which was decided the next year), Chief Justice TANEY said that it was held by the court in Le Roy *v.* Tatham, that the plaintiff "was not entitled to a patent for this newly discovered principle, or quality, in lead, and that such a discovery was not patentable:" p. 117. It would seem, therefore, that the doctrine of the minority on this point was not acquiesced in by their colleagues, though it was passed over in the opinion given for the majority.

The patent came under the consideration of the court again in the case of Le Roy *v.* Tatham, 22 How. 132, and was sustained in consequence of a new view which was taken of it. In delivering the opinion of the court, Judge MCLEAN took occasion to declare, in emphatic terms, that Lord HOPE'S doctrine was not law in this country.

In O'Reilly *v.* Morse, the principal question rose upon the eighth claim in the patentee's specification. It was expressed in these words, viz: "The use of the motive power of the electric, or galvanic current, however developed, for making or printing intelligible characters, signs, or letters, at any distance." The patentee did not pretend to have been the first one who had discovered that the electric current would produce motion at a distance. But he did claim, and truly, to have contrived a mechanism, or process, whereby it could be made to print characters at a distance. He set up a claim, therefore, to the exclusive right of doing this by any process or machinery whatever. This claim the court negatived in the most unequivocal terms, and Chief Justice TANEY, in delivering their judgment, used this language, which will bear repetition: "Whoever discovers that a certain useful result will be produced in any art, machine, manufacture, or composition of matter by the use of certain means, is entitled to a patent for it, provided he specifies the means he uses in a manner so full and exact that any one

skilled in the science to which it appertains can, by using the means he specifies, without any addition to, or subtraction from them, produce precisely the result he describes. And if this cannot be done by the means he describes, the patent is void; and if it can be done, then the patent confers on him the exclusive right to use the means he specifies to produce the result or effect he describes, and nothing more. And it makes no difference, in this respect, whether the effect is produced by chemical agency or combination, or by the application of discoveries or principles in natural philosophy, known or unknown before his invention, or by machinery acting altogether on mechanical principles. In either case he must describe the manner or process as above mentioned, and the end it accomplishes. And any one may lawfully accomplish the same end, without infringing the patent, if he uses means substantially different from those described:" p. 119. And he also declared that the doctrine of Lord HOPE is not law in this country.

After the elaborate discussion and full consideration which these cases underwent in the Supreme Court, it can hardly be required to examine at length those in which the subject has been touched upon in the Circuit Courts. What was said in substance respecting them by TANEY, C. J., in O'Reilly *v.* Morse, will answer the purpose. The earlier decisions are in uniform accordance with the ruling in that case, and the idea of patenting a principle is never mentioned but to be denounced. (See Evans *v.* Eaton, Pet. C. C. 341; Stone *v.* Sprague, 1 Story, 272; Wyeth *v.* Stone, Id. 285; Blanchard *v.* Sprague, 2 Id. 166, 170; 3 Sumn. 536, 540; American Pin Co. *v.* Oakville Pin Co., 3 Am. Law Reg. O. S. 137, and Law's Dig. 260); Smith *v.* Downing, Law's Dig. 593. A change was undoubtedly produced by the proceedings upon Neilson's patent, and the instructions of Lord HOPE were in several instances adopted as the law by the judges in their circuits. Parker *v.* Hulme, 7 West. Law J. 419, Law's Dig. 593, and Foote *v.* Silsby, 2 Blatchf. 265, may be mentioned among them. It is a grave mistake, however, to assert that the decision upon this question in the last case was affirmed in the Supreme Court. The question arose upon the first claim alone in the plaintiff's patent; and on the hearing in the Supreme Court it was expressly stated by the learned judge, NELSON, who pronounced the decision, that the first claim was found to have been anticipated, and was not before the court: Silsby *v.* Foote, 20 How. 378.

Since O'Reilly *v.* Morse was decided, the right to patent a principle has never received the slightest countenance from the bench, but, whenever it has been adverted to, it has been denied in unqualified terms. It was so in Le Roy *v.* Tatham, 22 How. 132. In Wintermute *v.* Redington (U. S. Cir. Ct. N. D. Ohio, 1856), a patent was tried which eminently deserved all the favor to which the discovery of a new and valuable law of physics could entitle it, it being for the well-known reaction water-wheel. Yet the learned judge, WILSON, who presided at the trial, used the following language respecting it: "If the defendant, in the use of a reaction water-wheel, whether on a vertical or horizontal shaft, whether single or in pairs, has run, or caused it to be run by the aid of the vertical motion of the water upon the wheel in its line of motion, he has violated the patent; *provided he has used, in so doing, any or all of the patentee's mechanical means for producing that vertical motion, or mechanical equivalents for all or any of them to produce it.*"

We may now recur to the cases which are usually referred to in discussing this branch of the law, and which have been passed over. It will be found, on examination, that they, every one of them, involved an invention consisting exclusively in the new application of some law of mechanics, or what is equivalent to such a law. And what were held to be infringements consisted in the employment of what were mere mechanical substitutes for the devices which the patentee had described in his specification. They were neither more or less than equivalents for those devices, at least they were so regarded by the court. It is true that the judges frequently speak of the principle of the patented structure, and vindicate the patentee's exclusive right to it. But the term principle is used by them in a qualified sense. As Judge STORY said in Barrett *v.* Hall, "care should be taken to distinguish what is meant by a principle. In the minds of some men, a principle means an elementary truth or power," &c. "No one, however, in the least acquainted with law, would for a moment contend that a principle in this sense is the subject of patent." "The true legal meaning of the principle of a machine, with reference to the Patent Act, is the peculiar structure or constituent parts of such machine:" 1 Mass. 470. So it was said also by Judge MCLEAN in Brooks *v.* Jenkins, "The word principle is not used here in its general signification, but as applied to the structure of a machine. It means the operative cause by which a certain effect is produced:" 3 MCLEAN, 451. Or, as Judge

STORY defined it on another occasion, it means "the *modus operandi*, the peculiar manner or device of producing any given effect." Whittemore *v.* Cutter, 1 Gall. 480. When, therefore, we find it announced from the bench that the patentee, having shown one way in which this principle of his machine is made to work effectively, is entitled to the use of all other ways in which it may be utilized for that purpose, we spprehend that nothing more is intended than that his patent shall not be evaded by what are only equivalents for the mechanisms he employed.

In Jupe *v.* Pratt. 1 W. P. C. 145, for instance, there can be no pretence that the plaintiff had found out any new property of matter, any law of physics, or even any new principle of mechanics. He had, at the most, made an ingenious and novel application of well-known mathematical truths. This enables us to understand the just import of the language used by Baron ALDERSON on that occasion, which has been so often quoted. He first denied explicitly that a patent can be taken out for a principle. He adds, however, "You may take out a patent for a principle, coupled with the mode of carrying that principle into effect, provided you have not only discovered the principle, but invented some mode of carrying it into effect. But then you must start with some mode of carrying it into effect; if you have done that, then you are entitled to protect yourself from all other modes of carrying the same principles into effect, that being treated by the jury as piracy of your original invention." Now, if the learned judge intended by principle any law of nature, then his remarks were entirely foreign to the case. The plaintiff had made no such discovery, and, if he had, his discovery of it would have given him no property in what he discovered. But, if his lordship is understood to be speaking of what has been sometimes called the *modus operandi* of the invention, he is intelligible and consistent, and in harmony with what has been advanced above. The patentee of such an invention must have originated the principle in that sense. And having originated it, and described one method of applying it, he is entitled to all other methods of applying it. For all other methods of applying such a principle can be nothing more or less than substituting some equivalent or other for the mechanical device or devices, which are embodied in the method he has described.

So of Crossley *v.* Beverley, 1 W. P. C. 106, 3 C. & P. 513. The operation of the machine, for which the plaintiff had a patent, de-

pended upon a well-know law of hydrostatics, the tendency of water to rise to the same level, wherever different bodies of it are in free communication. A great deal was said about the principle of the machine, the experts testifying that after the principle was once discovered, there were a hundred ways of reducing it to practice. Now they could not be speaking of the law of hydrostatics, which has been known from time immemorial. They evidently meant the *modus operandi*, the principle of mechanism by which that law was made to contribute to the purpose of the machine. The defendant's machine was wholly unlike the plaintiff's in appearance, and even in construction. But it was shown to operate upon the same principle, and so was held to be an infringement. Not because he availed himself of the same law of hydrostatics—everybody might make use of that. But he employed the same mechanical principle of operation. In other words, his devices were mere mechanical equivalents for those which were described in the plaintiff's patent.

Again, in Walton *v.* Potter, 1 W. P. C. 585, 3 M. & G. 411, 3 Scott N. R. 91, the patentee had made no discovery of any law of physics. He had merely made an ingenious application of the well-known qualities of India rubber, in order to hold the teeth of wool-cards in a suitable position, yet have them flexible. He used for this purpose a sheet of the gum between two layers of cloth. The defendant used cloth enveloped in the gum, by having been dipped in a solution of it and dried, and thus effected the same object: and he was held to have infringed the patent. Why? Because he used India rubber? No; but his fabric operated on the same principle; that is, the same principle of mechanics; and was a mere substitute for that of the plaintiffs'.

We have seen that the plaintiffs' patent in Neilson *v.* Harford, was construed to cover the process of heating the air in a vessel placed between the blowing apparatus and the furnace. The defendant used a vessel in that position for the same purpose; but the construction of it was entirely different from that of the plaintiffs'. It was held, nevertheless, to be an infringement. It performed the same functions, more effectually it is true, but still the same. In a mechanical point of view it operated on the same principle, and was its counterpart.

(To be continued.)

# EDUCATIONAL

## CHEMICAL EXPERIMENTS FOR THE LECTURE-TABLE.

By Prof. Albert R. Leeds.

*Exhibitions with the Lantern of the Reactions of Gases upon Solutions.* The tank employed for these experiments is preferably of the kind figured by Prof. Morton, in the October No., 1867, p. 281, of the *Journal*. Its especial advantage is the rapidity with which it may be taken apart and cleansed. The best form of generator for obtaining the supply of gases is that which is customarily employed for the evolution of small quantities of sulphuretted hydrogen. It is a small bulb of thin German glass, which is provided with a wide neck for the introduction of materials, and a small tube entering the first at right angles, and bent downwards in order to carry the gases into the liquids to be tested. It is well to break the exit tube at the bend, and then to connect the broken parts again by India-rubber tubing. This prevents awkward accidents on future occasions, and much facilitates the introduction and withdrawal of the exit tube from the tank.

If a small quantity of black oxide of manganese and hydrochloric acid be placed in the generator, there will be a slow evolution of chlorine in the cold—quite rapid enough, however, for many experiments—and a copious supply when the flask is gently heated. If this gas be passed into a dilute solution of potassic iodide and starch, the iodide of potassium will be decomposed, and its liberated iodine, coming into contact with the starch, will form a cloud of dark-blue iodide of starch with each successive bubble of chlorine. So if a drop of mercury be poured into the generator, and a drachm of nitric acid added, the liberated gas will decompose the potassic iodide in like manner, and the production of the starch iodide will be shown by the rays passing from the lime-light through the tank and falling upon the screen. If the tank be filled with colored liquids formed by adding solutions of litmus, logwood, cochineal, sulphate of indigo, the various analine dyes, ink, &c., to clear water, and bubbles of chlorine be passed in, a few seconds in each case

will be sufficient to show the bleaching action of the gas, and the light will break through where the gas is entering, and gradually spread over the screen until the india-rubber walls of the tank become discernible.

Or if a solution of iodide of potassium and common sulphuric ether be employed, and chlorine passed through the liquid, the liberated iodine will dissolve in the ether and form a dark-brown superstratum; this experiment is of a very striking character. A similar result will be obtained with bromide of potassium and ether.

When to a small amount of mercury a quantity of sulphuric acid is added in the flask, and strongly heated, a large amount of sulphurous acid is disengaged, which exerts upon different coloring substances its well-known bleaching action. The purple color of litmus is speedily changed to red, but the decoloration does not proceed to such a point as to prove satisfactory in these experiments. The same remark applies, in a greater or less degree, to the other dye-stuffs: chlorine is much more satisfactory. Passed into a solution of chloride of barium, the sulphurous acid-gas (owing, of course, to the presence of small quantities of sulphuric acid,) produces a precipitate of sulphate of baryta. It is better to add the chloride of barium to a colorless solution of sulphurous acid in water, which has been previously placed in the tank, and afterwards pass in the gas evolved from the action of nitric acid upon charcoal, mercury, copper, &c. The oxidation of the sulphurous to sulphuric acid by the hyponitric acid bubbles, is immediately evinced by an abundant precipitate of barytic sulphate. This is an elegant preliminary experiment to the lecture-room demonstration of the commercial mode of manufacturing sulphuric acid.

Another interesting series of experiments may be performed in the same manner, upon the qualitative analysis, by means of sulphuretted hydrogen gas of solutions of the various common and noble metals. Sulphide of antimony and hydrochloric acid are to be preferred to sulphate of iron and dilute oil of vitriol for the production of the gas. On applying a very moderate heat, the sulphuretted hydrogen bubbles rapidly through the liquid in the tank. If the latter contain a dilute acid solution of persulphate of iron, there is a clouding up of the screen, from the separation of sulphur. In an acid solution of nitrate of cadmium, arsenious acid or bichloride of tin, a precipitate of the yellow sulphide of cadmium, orpi-

ment or aurum musivum become apparent. Passed through a dilute solution of terchloride of antimony, the gas produces an orange-colored precipitate of tersulphide of antimony visible upon the screen; and through protochloride of tin, a dark-brownish red cloudiness of protosulphide of tin. Still more striking than the former are the brownish-black, or, as seen by transmitted light upon the screen, the dense black clouds of the protosulphides of lead, copper, bismuth, the bisulphide of platinum, and the tersulphides of bismuth and gold, which are formed when the hydrosulphuric acid is made to bubble through dilute acid solutions of any of the soluble salts of these elements.

The precipitation of the carbonates of lime, baryta, strontia, lead, &c., may likewise be shown upon the screen, by passing carbonic acid from the usual carbonic acid generator into aqueous solutions of the hydrates of these alkalies, or into the basic acetate (called, in the Pharmacopœa, Goulard's Extract,) of lead, &c. The last-named experiment is particularly useful in the explanation of the French method of Ceruse manufacture. The presence of carbonic acid in the breath may, likewise, be pleasingly exhibited by passing the expired air through a glass tube into lime-water, or, what is much more delicate, a solution of basic acetate of lead in rain or diluted water in the tank.

Finally, to exhibit the action of ammonia, the small gas-generator, mentioned at the beginning of the article, should be about half filled with a mechanical mixture of equal parts of powdered caustic potash or quicklime, with sal-ammoniac. When the ammoniacal gas, evolved on heating, is passed through a solution of alum or other salt of alumina, a precipitate of hydrate of alumina is rendered evident. In a solution of oxide of zinc, provided free acid be not present in excess, the gas forms a precipitate of hydrated oxide of zinc, which dissolves in an excess of the zinc solution. With a solution of protochloride or sulphate of manganese, the ammonia forms a whitish-gray precipitate of hydrated protoxide of manganese, rapidly altering to a dark brown by exposure to the air. In a solution of sulphate of nickel, the gas produces a green cloudiness, dissolving on a continued addition of ammonia, to a blue liquid, containing a compound of protoxide of nickel and ammonia (fresenius). In chloride or nitrate of cobalt, a blue precipitate, altering to green, is first formed, and afterwards dissolved by an excess of the gas to a greenish-brown (?)—reddish-brown, fresenius—fluid. From a solu-

tion of protochloride or protosulphate of iron, the ammonia separates a white precipitate of hydrate of protoxide, rapidly changing to green and reddish-brown, from the persulphate a precipitate of the sesquioxide of iron. A few bubbles of ammonia passed into nitrate of silver, produce a grayish-white(?)—brown, fresenius—precipitate of oxide of silver, disappearing as a further supply of the gas enters. In the basic acetate of lead, there is an immediate white precipitate. So from the solutions of corrosive sublimate, nitrate of cadmium, protochloride of tin and terchloride of antimony, the introduction of the ammoniacal gas is followed by the formation of white precipitates. In a concentrated solution of terchloride of gold, there is an immediate deposition of reddish aurate of ammonia (fulminating gold). In a solution of sulphate or other salt of copper, the first portion of ammoniacal gas introduced gives rise to a greenish-blue precipitate of a basic salt of copper, dissolving on a further involution of the gas, to an azure-blue basic double salt of ammonio-oxide of copper (fresenius). The delicacy of Nessler's test may form an interesting conclusion to these experiments with ammonia. The test liquid is prepared by dissolving a small quantity of potassic iodide in water, heating the solution, and adding mercuric iodide until the portion last added remains undissolved. The mixture, after considerable dilution, is mixed with a somewhat greater quantity of a concentrated solution of potassic hydrate. If the latter gives rise to turbidity, the solution is to be filtered again. The first few bubbles of ammoniacal gas produce a copious reddish-brown precipitate.

*To Render Carbonic Acid Gas Visible.* When a generator of carbonic acid gas is placed in front of a screen illuminated with the magic lantern, and separated from the former by an interval of about six feet, the stream of gas issuing from an exit tube of the generator becomes evident as a series of wavy descending lines upon the screen. A candle, placed at the bottom of a tall jar, produces an ascending current, and this, together with the extinction of the light by falling carbonic acid, may be projected upon the screen by rays from the lantern. In like manner, a current of carbonic acid gas, or of ether vapor, issuing from the longer limb of a syphon, when the gas in both the upper and lower vessels has previously been invisible, may be made evident to the eye. The convection of air, when a hot iron ball is placed in front of a screen, is a pleasing experiment of a similar description.

*Reduction of Metallic Oxides by Means of Burning Gas.* It will be found, by those who have the opportunity of using ordinary burning gas, that it may be employed to illustrate the subject of reduction, by passing a stream of the gas over an oxide, such as the red oxides of mercury and lead, strongly heated in the bulb of a reduction tube. The sides of the tube become covered with moisture, and after a time globules of mercury collect, and, by tilting the tube, may be made to run out. The temperature required is much lower than that which is essential to direct decomposition. A pleasing method of showing the reduction of oxide of lead by another method—with charcoal—may be performed in the following manner: pulverize together, in a tin tray, an excess of charcoal with some potassic chlorate and plumbic oxide. Upon applying a match to the mixture, beautiful clouds of oxide of lead are given off; and, if a large bell-jar be inverted over them, they will form a yellow sublimate upon its inner surface. Some of the plumbic oxide is reduced by the charcoal to the metallic state, as will be perceived upon pulverizing the residue with a spatula, and washing with water, when the light particles of carbon will be carried off, and metallic lead remain behind. Throw the latter upon an anvil, and strike with the hammer, when a disc of metallic lead will be obtained.

*Portable Magic Lantern.* With the aid of the magnesium lamp and the portable lantern described below, together with a few chemicals, diagrams, views, and a few simple pieces of apparatus, one may carry a course of brilliant, popular lectures along with him in a portmanteau. There is a rectangular frame of walnut, or other strong wood, seven inches broad and twelve long, provided with a groove on its upper surface, which serves as a base for the magnesium lamp, and permits it to be run backward and forward until it is accurately focussed. A similar second frame, six inches long, is fastened to the first at one end, by means of hinges placed on the lower side, and a hook upon the upper side. When the latter is fastened, the base is thus lengthened out to eighteen inches. Attached to the anterior end of the first described half of the base, there is an upright of wood, which carries the condenser. The cell of the condenser projects on the posterior face of the upright, and there are hinges placed at the bottom and back of this upright, so that when folded backward the condenser may drop into the open space left by the sides of the frame. A hook and staple on the front side which fastens this upright to the second half of the base, pre-

serves all parts in position. The upright for the objective tube is also provided with a hook and hinges, and folds upon its portion of the base in a similar manner. When not in use, the tube of the objective, which should be arranged so as to slip into a cell, and thus admit of ready attachment and removal, may be packed away in the space left by the condenser in the frame of the base. When not in use, the lantern has the appearance of four pieces of wood.

(To be continued.)

## THE MAGIC LANTERN AS A MEANS OF DEMONSTRATION.

(Continued from page 347.)

### LANTERN PICTURES.

After all that has been published in photographic journals on the subject, it would be at least tiresome here, to say anything about the best modes of making photographic transparencies. We will only advise those using such pictures, in all cases if possible, to try in the lantern before purchasing, as without long practice and much care, one is easily deceived and may select as an admirable picture, one which in use is most unsatisfactory.

The use of photographs from engravings and woodcuts, in connection with the thorough study of various branches, such as is or ought to be pursued in colleges and schools, open to the teacher a wide field for the illustration of his subject, by which the interest and instructiveness of his course may be largely extended. With a good lantern and screen, enough diffused light from an open window or gas burner may be admitted, to give every facility to the class for taking notes, while the pictures illustrating the subject, are yet clearly defined upon the screen.

We speak here from experience, having employed this plan during the past winter, at the University of Pennsylvania, with entire success. In this case, perfect transparency of the film in all *white* parts of the picture, combined with great opacity in the dark lines, is of paramount importance, and in this connection we can speak most highly of the very numerous specimens furnished us by O. H. Willard (often made at an hour's notice, the same day that they were first used), which leave nothing to be desired in both these respects.

In many cases, however, it becomes desirable to prepare some

simple drawing or diagram, which would not seem worth the time and cost of photographing.

Several courses then present themselves.

1st. We may prepare a glass plate by flowing it with collodion, sensitizing in the silver bath, exposing to bright sunlight, and developing, and then draw with a sharp steel point the desired figures.

This drawing may be done in the lantern, as suggested by my friend, Prof. Leeds, with very excellent effect.

The advantages and drawbacks of this plan under various conditions, are manifest without enumeration.

2d. We may draw on glass directly with India ink, using both brush and pen, as described in this *Journal* some time since, in connection with pictures of sun-spots thus prepared and exhibited at one of the meetings of the Institute. The plan to be adopted is as follows: The glass plate to be employed, should be thoroughly cleaned and rubbed with paper moistened with a drop of alcohol. The India ink employed should be of that kind known as Japanese, which will not soak out in water, but requires to be rubbed on a slab or plate (for which a piece of ground glass is the best material), and which is of rather a greasy than aqueous character. If lines only are to be produced, the ink should be made as thick as possible, short of preventing it from flowing from the pen. Perfectly sharp lines can then be produced with certainty, and no risk of blotting or running out upon the glass. If circles are to be struck, a fragment of paper may be pasted at the centre, to serve as a support to the stationary point of the compass, and scratched off after the drawing of these parts is finished. A strip of card held firmly at one end, will also answer where an entire circle is not required. Where half tones are required, these should, if possible, be put in first with thin color, and rather too dark than too light. Then with a needle mounted in a stick or fine point of compasses, the shade may be lightened by stippling, or a series of light blows, producing dots of light in the shade, or by fine circular lines or circles intersecting and crossing each other in every direction. Lastly, with a stiff brush cut off short and lightly applied, first to some thick ink and then to the glass, black stippling may be easily and rapidly applied.

These are the only precautions, beside patience and practice, that need be here recommended.

3d. We may draw or trace with India ink on the thin white or

colorless sheet gelatine, used by engravers, and then enclose the sheet between glass plates. This plan I first employed some days since, when my assistant, Mr. Alex. Outerbridge, Jr., suggested that woodcuts and lithographs might be printed off on this same material, from the blocks or stones, and employed in like manner.

This plan on trial, proved perfectly feasible, and has been of the greatest use in various connections. It promises, in fact, to open a vast field to the lantern system of illustration, for the cost of reproduction of any existing woodcut or lithographic drawing, for this purpose, is thus rendered insignificant.

Mr. Outerbridge has also succeeded in preparing sheets of gelatine of the most excellent character, for this purpose. An account of the process by which they are made will be found at page 300 of this *Journal.*

With regard to the coloring of photographs or other transparencies, we know very little, and wish very much that some one practically conversant with the matter would place some of his information before the public.

For mere purposes of indication, common water colors, varnished when dry, will be of use, and of course, colors ground in drying oil or varnish, will answer better yet, where the work required is of sufficient extent to repay for the time expended in their preparation. The best effects, however, are reached by flowing the plate with albumen, and painting with aniline colors.

(To be continued.)

## ABSORPTION OF GASES BY CHARCOAL.

By Professor Albert R. Leeds.

In Watts' excellent Dictionary of Chemistry, Vol. 1, p. 761, there is an account of the absorptive power of charcoal upon gases, which has been taken chiefly from the late researches of Dr. Stenhouse. Having repeated and somewhat extended these experiments, I have thought that so much as follows may be of general interest.

Some pieces of charcoal prepared from a cocoa-nut shell, and which were of a dense, lustrous character, were placed in a tube, and a stream of sulphuretted hydrogen, previously dried with chloride

of calcium, passed over them. After the lapse of ten minutes, the tube was detached, and indicated on the balance an increase of weight, due to the absorbed gas. A current of oxygen was next passed over the charcoal; the tube became slightly warm, owing to the oxidation of the hydrosulphuric acid, but in no case, in a number of experiments, was there (as I have seen it stated), a spontaneous ignition. On heating with a spirit-lamp, vapor of water was condensed upon the sides of the tube, and sulphur deposited; sulphurous acid not perceptible. When platinized was substituted for ordinary charcoal, the amount of moisture and sulphur was increased. Even in this instance, however, ignition was not spontaneous, but followed on the application of the spirit-lamp for a few moments.

By depositing finely divided platinum upon the surface and in the pores of the charcoal, a variety of interesting results were obtained. This may be effected by boiling charcoal in lumps or powder in a solution of bichloride of platinum for five to fifteen minutes, according to the size of the pieces, and then heating the charcoal to redness in a platinum crucible; holding the charcoal in the flame of a spirit-lamp will answer. A piece platinized in this way was immersed in a jar, containing one measure of oxygen, and two of hydrogen; the charcoal glowed with a dull red light, and effected a silent combination of the mixed gases. A more highly platinized fragment lit up instantaneously, the jar became clouded with smoke, and union was determined with explosion. In a stream of hydrogen, the platinized charcoal, which was previously at the temperature of the room, ignited quickly throughout and set fire to the gas. In oxygen, no action apparent. Held before the nozzle of the compound blow-pipe, the jet was speedily lighted. When previously warmed, the platinized charcoal became incandescent in burning gas, but did not inflame it, owing to the high temperature at which coal gas ignites. In alcohol vapor, there was no action apparent in the cold, but a spark previously formed in the flame of a lamp, increased in size with the production of acid vapors. A mixture of one volume of hydrogen and one of chlorine was not ignited; whether hydrochloric acid was silently formed at a slow rate was not determined. The importance of such experiments in relation to ventilation and disinfecting will be readily perceived.

# Franklin Institute.

**Proceedings of the Stated Monthly Meeting, April 22d, 1868.**

THE meeting was called to order with the Vice-President, Mr. Coleman Sellers, in the Chair.

The minutes of the last meeting were read and approved.

The Actuary submitted the minutes of the Board of Managers, and reported that, at their stated meeting held April 8th, inst., donations to the Library were received from the Royal Astronomical Society and the Society of Arts, London, and the Association for the Prevention of Steam Boiler Explosions, Manchester, England; la Société Industrielle, Mulhouse, and Thomas W. Evans, Esq., Paris, France; the Canadian Government, Ottawa, Canada; P. W. Sheafer, Pottsville, Penna.; Messrs. Henry R. Campbell, John Clayton, B. Henry Bartol, and the Mercantile Library Company of Philadelphia.

Also, that the following resolutions were passed:

*Resolved*, That it is expedient to postpone the exhibition intended to be held this year.

*Resolved*, That the Committee on Exhibition in 1868 be continued, and that their report, with proposed plan of organization, be referred back to them for further action.

The various Standing Committees reported their minutes. And the Special Committee appointed to prepare resolutions on the death of Sir David Brewster, reported that they would present to the Institute the following resolutions for their action:

*Resolved*, That in the death of Sir David Brewster, a serious loss has been sustained by the world of science, not only by reason of the vast store of information and skill thus removed from among the laborers in her fields, but also by reason of the interruption of studies and investigations tending to throw light upon many obscure subjects in the direction of optical research.

*Resolved*, That in the death of Sir David Brewster, the world at large has lost one of those who have contributed, by their labors, in a marked degree, not only to the progress of science, but also to the general diffusion of information and the development of a taste for the refining and cultivating study of the physical sciences.

*Resolved*, That a copy of the above resolutions be transmitted to the family of the deceased.

A paper, by Mr. Charles H. Rockwell, on the Suez Canal was then read by the Secretary, and the thanks of the Institute were tendered to Mr. Rockwell.

Prof. Rogers gave a short history of Electro-Magnetism and its connection with Magneto-Electricity, and explained one of Wade's New Magneto-Electrical Machines as improved and made by Ladel, of London. Some ingenious French Syphon-Filters were also exhibited by the same gentleman.

The Secretary's report was then read. After which, the meeting was, on motion, adjourned. HENRY MORTON, *Secretary.*

# Bibliographical Notice.

*The Workshop.* A monthly Journal devoted to the Progress of the Useful Arts. Edited by W. Baumer and I. Schnorr. E. Steiger, 17 North William Street, New York.

We have received from Mr. Steiger, several numbers of this very admirable publication. It is a large quarto pamphlet 10 by 12½ inches, with 16 pages in each number, of which 13 are devoted to illustrations in the shape of admirable wood-cuts, while 3 are filled with printed matter.

The style of the work as regards artistic merit of designs and engravings, printing and paper, is admirable; as regards its scope, the following enumeration may suffice:

"This periodical is the American edition of a German monthly, '*Die Gewerbehalle*,' which has a very large circulation, and is now being published simultaneously in German, French and English.

"*The Workshop* is devoted to Progress in all departments of the Useful Arts. It gives Descriptions and Designs, with details in large size, for most classes of trades, for architects, builders, cabinet and furniture makers, carpenters and joiners, carriage makers, carvers, sculptors, stone cutters, stuccoers and plasterers, decorators, designers, engravers and lithographers, founders, gilders, gold, silver and metal workers, jewelers, painters, upholsterers, weavers, for manufacturers of bronzes, britannia ware, gas fixtures, clocks and watches, china, crystal, earthenware and glass, fancy goods, embroideries, trimmings, ribbons, mouldings, as well as for artists generally, and all others having a chance to show taste in their work. Price $5.40 a year; single numbers, if to be had, 50 cents.